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THE ENGINEER

A Seven-Day Journal

Industrial Standardisation Committee

IN the House of Commons on Thursday of last week, the President of the Board of Trade, Mr. Harold Wilson, announced the formation of a committee "to consider the organisation and constitution of the British Standards Institution, including its finance, in the light of the increasing importance of standardisation and the extended size and volume of work likely to fall on the B.S.I. in future." He stated that Mr. Geoffrey Cunliffe had agreed to act as chairman, and that the other members were Sir William Palmer, British Rayon Federation; Mr. A. V. Nicolle, the Automotive Engineering Company, Ltd.; Mr. Roger Duncalfe, British Glues and Chemicals, Limited; Mr. E. P. Harries, Trades Union Congress; Mr. O. W. Humphreys, General Electric Company, Ltd.; and Sir Ernest Lemon, chairman of the Ministry of Supply Committee on Engineering Standardisation. In making this announcement Mr. Wilson recalled the setting up, by the Minister of Supply last November, of a committee to investigate the possibility of reducing the variety of engineering products and components. He said that the Government was fully alive to the economic contribution which standardisation could make, and was convinced that the policy should be to encourage the progress of standardisation by every possible means, looking to industry, in conjunction with the British Standards Institution, to do the work. It was clear, however, Mr. Wilson continued, that further advances in standardisation, whether in the engineering field or elsewhere, would not be obtained without a good deal of hard work and careful technical examination, and without the fullest co-operation of industry in the drafting and adoption of standards. That would mean that the B.S.I. would have more work to do and would assume an even more important place in the economy of the country than it did at present. The question of an increased grant would have to be considered, but it seemed necessary first that the constitution and functions of the Institution should be reviewed in the light of the policy advocated. It was for that purpose that the committee had been appointed.

Launch of the P. and O. Liner "Chusan"

ON Tuesday, June 28th, at the naval construction works of Vickers-Armstrongs, Limited, the launching took place of the Peninsular and Oriental Steam Navigation Company's new liner "Chusan," the third ship in the P. and O. fleet to bear that name. The launching and naming ceremony was gracefully carried out by Viscountess Bruce. The new "Chusan" has an overall length of 672ft 6in and a breadth, moulded, of 85ft, with a depth, moulded to "E" deck, of 48ft, and a draught of 29ft. She will have accommodation for 484 first-class and 540 tourist-class passengers, and will carry officers and crew numbering 557 persons. With her single buff funnel and white hull with a streamlined bridge structure she will, when completed, present a pleasing appearance. Her holds, which are served by six hatches, are designed to carry 437,000 cubic feet of cargo, and include 100,000 cubic feet of refrigerated space. Her propelling machinery, which is well advanced, consists of a twin-screw arrangement of Parsons geared steam turbines, having a normal power of 34,000 s.h.p. and an overload capacity of 42,500 s.h.p. Steam is generated in two large and two small water-tube boilers of Foster-Wheeler controlled superheat design, giving superheat control from 850 deg. Fah. down to 525 deg. Fah. when manœuvring. The auxiliary machinery includes four B.T.H. turbo-dynamos, each of 850kW capacity, and two 100-kW Ruston and Hornsby oil engine-driven emergency generating sets. The "Chusan" is expected to enter her owner's Eastern service in the spring of 1950.

The Road Passenger Executive

THE Minister of Transport announced on Monday last that, following consultation with the British Transport Commission, he had made an Order providing for the establishment of an Executive to be known as the Road Passenger Executive, and for the name of the Road Transport Executive to be changed to the Road Haulage Executive. Mr. George Cardwell has accepted the Minister's invitation to serve as Chairman of the Road Passenger Executive, the other members of which are Mr. W. V. Morland, M.I. Mech. E., Mr. James Amos, Mr. W. Beckett, and Mr. Stanley Kennedy, the last-named three serving as part-time members. In taking up his new office, Mr. Cardwell will vacate his seat on the Road Transport Executive, to which he was appointed last year.

Education for Management

THE Ministry of Education announced at the end of last week that, in conjunction with the British Institute of Management, it had formulated a scheme to improve the training arrangements for part-time students in industry and commerce. By this scheme, those who wish to take up positions in administration and management will be enabled to follow systematic courses of study leading to an Intermediate Certificate and to the more advanced award of a Diploma in Management Studies. For the Intermediate Certificate students will take a three-year part-time course concurrently with commercial or industrial employment, and must have reached a minimum age of twenty-three before completing the course. For the Diploma, there will be a specialised and general course. Students must have obtained an Intermediate Certificate or be otherwise suitably qualified to pursue more advanced study in management subjects, and must have reached a minimum age of twenty-five before completing the course, which will last two years. The Ministry says, however, that where the experience and age of students merit special consideration, full-time courses or other alternative arrangements may be made. It is explained that the scheme follows the recommendations of the Urwick Committee's report on Education for Management, which was published two years ago, and which estimated that nearly 500,000 men and women were employed in managerial positions and that recruitment was at the rate of 12,000 a year. The report pointed out that whilst theoretical training alone was not sufficient, courses of study were of importance and that in recent years the demand for such courses in technical and commercial colleges had grown rapidly. The requirements of the various management interests, however, had varied considerably, a matter which created a serious problem for the colleges and which tended to dissipate their facilities.

The National Physical Laboratory

THE Department of Scientific and Industrial Research has announced the forthcoming retirement of Sir Charles Darwin, F.R.S., from the position of Director of the National Physical Laboratory, to which he was appointed in 1938. Professor E. C. Bullard, F.R.S., who is at present Professor of Physics in the University of Toronto, has been appointed to succeed Sir Charles, and is expected to take up his duties at the N.P.L. next January. Professor Bullard, who is in his forty-second year, was educated at Repton and at Clare College, Cambridge. He became Demonstrator in Geodesy at Cambridge University in 1931, and was elected to the Smithson Research Fellowship of the Royal Society in 1936. During the war Professor Bullard was engaged on work for the Admiralty in connection with measures against the acoustic mine, and for the last year of the war he served as Assistant Director of Naval Operational Research. In 1945 Professor Bullard became Reader in Experimental Geophysics at Cambridge University, and last year took up his present post at Toronto University.

Loss of the Belgian Steamer "Prinses Astrid"

IT is with regret that we record the loss of the Belgian Ostend-Dover cross-channel steamer "Prinses Astrid," which struck a mine 3 miles off Dunkirk on Tuesday, June 21st. Five men, all Belgians, were drowned when the side of the ship was blown in by the explosion. Happily, the weather was fine, and it was possible to disembark all the 218 passengers, many of them British tourists, and the crew of 65. Immediately after the explosion, the ship was swung on to a sandbank, where she took on a list of 60 deg. Two tugs tried to tow her into shallow water, but before this could be done she sank and settled back on an even keel with only her funnel and masts visible. Passengers were treated for shock at Dunkirk and Dover, and special railway and steamship arrangements were made. The "Prinses Astrid" was built at Hoboken by the Soc. Anon. John Cockerill, and was one of two steamers fitted with high-pressure and high superheat machinery, and with a new type of hull and more covered accommodation for passengers. On Wednesday, June 22nd, the Admiralty issued a statement concerning the work of the East Atlantic zone of the International Mine Clearance Board, which considered the sinking. This statement explained that the channel had been thoroughly swept and had been in constant use, not only by cross-channel ships but by other vessels for about three years. The appearance of a mine and that of a second mine reported the next day may have been due, it was thought, to the washing clear of a buried mine by currents or to disturbance by trawling operations.

The Late Major-General S. C. Peck

AUTOMOBILE engineers in particular will learn with regret of the death of Major-General Sydney Capel Peck, C.B., which occurred on June 25th. He was in his seventy-eighth year. Major-General Peck was educated at Perse School, Cambridge, and at Sidney Sussex College, Cambridge, and in 1900 was nominated by Cambridge University for a commission in the Royal Artillery, serving in Northern Nigeria in 1902–1903. For some years following he held various appointments at Woolwich Arsenal, where for one year prior to the first world war he was Assistant Inspector. From 1915 to 1918 Major-General Peck was on active service in France, and in 1919 headed the British Mission at Fiume. A year later he was appointed British Commissioner and President of the Klagenfurt Inter-allied Plebiscite Commission, South Austria. Having completed his duties in that office, Major-General Peck returned to this country to become, in 1923, Assistant Director of Artillery, War Office. Subsequently he took charge of the newly formed Directorate of Mechanisation at the War Office. He was placed on retired pay in 1933. He was created C.B. in 1927. Major-General Peck served for many years on the Council of the Institution of Automobile Engineers, and was elected President in 1937.

Work of the Mersey Docks and Harbour Board

No I

SINCE the end of the war a considerable volume of civil engineering work has been carried out by the Mersey Docks and Harbour Board. The repair of damage caused by air attack and the completion of constructional schemes which were in progress before the war, but were suspended in 1939, have fully occupied the Board's engineers during the past few years. At the present time the deleterious effects of the war years, both from the point of view of direct damage and neglect of maintenance or constructional work, have been almost completely remedied, and the Board is now in a position to undertake further improvements in the dock estate, the principal scheme at present envisaged being the provision of a modern entrance lock to the Langton, Brocklebank and Canada docks, which was described in THE ENGINEER of February 4, 1949, and which will soon be commenced.

Work which has recently been completed includes the construction of the central river entrance at the West Waterloo dock, which was formally opened on March 29th, and repairs to the Gladstone-Hornby lock, whilst the reconstruction of several dockside sheds is in progress and rebuilding of other sheds has been completed. Also, the construction of training walls in the sea channel approaches to the River Mersey was resumed in 1946, after a lapse of seven years, and is still continuing. Various other works, such as the reclamation north of Gladstone dock, where rubble is being tipped along the foreshore, are also being carried out, and the various improvements which have recently been effected include the construction of a timber yard and the provision of a radar installation. The latter was described in THE ENGINEER of August 6, 1948. A plan of the northern section of the docks on the Liverpool side of the River Mersey is given in Fig. 1.

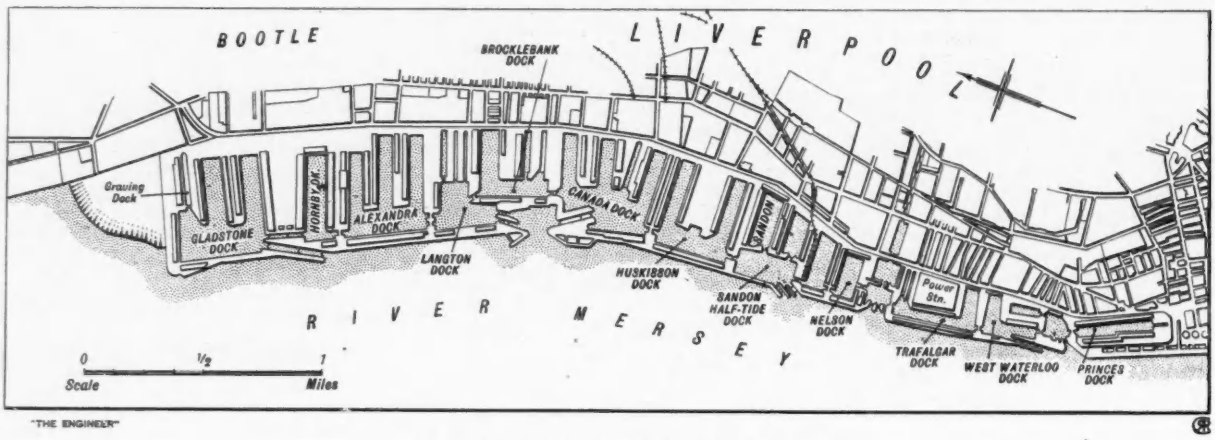


FIG. 1—PLAN OF NORTHERN GROUP OF DOCKS

LIVERPOOL BAY SEA CHANNELS

The construction of revetments and training walls in the sea channel approaches of the River Mersey has been in progress since 1909, and an interesting account of the history of this work has recently been given in a paper read before the Institution of Civil Engineers.*

The position and extent of the walls, which are constructed of lumps of limestone quarried nearby in North Wales and dumped into position from hopper barges, is shown in Fig. 2.

In 1932, following experiments made with a working hydraulic model, the Mersey Docks and Harbour Board embarked upon a large scheme of training and dredging to improve the sea channels of the River Mersey. This scheme had been only partly completed at the outbreak of war, when the entire work was suspended with the exception of a small amount of maintenance dredging. The walls had then been completed up to the points *A* and *B* in Fig. 2.

Throughout the war it was not possible to survey the sandbanks in the bay, and soundings had to be confined to the narrow mine-free swept channels between the buoys. The movements of the sandbanks and lesser channels were therefore quite unknown throughout these six years. Upon the cessation of hostilities a larger survey was made, when it was found that the training walls, so far as they had been constructed, had functioned quite successfully, but as the progress of the scheme had been interrupted, the channel beyond the seaward limit of the walls had deteriorated to some extent. The training walls had, of course, deteriorated also, due to lack of maintenance work, but not to an unexpected extent.

Topping-up the existing walls to the required level was commenced in 1946, when about 100,000 tons of limestone was placed. This work was continued in 1947, together with some extension of the walls seawards on the alignments laid out in the original scheme. During the year, six 650-ton steam hopper barges were employed in this work, dumping about a quarter of a million tons of limestone. In the same period sand pump dredgers removed about six million tons of sand from the sea channels and adjoining sandbanks, and by the end of the year the wartime neglect had been almost rectified and some progress had been made in pushing forward the scheme from the point where it had been left in 1939.

During 1948 the work continued at about the same rate, nearly a quarter of a million tons of limestone being placed during the course of the year, the walls being extended to the points *C* and *D* in Fig. 2. A total of about 16 miles of training walls had been built by the end of 1948 and a further 3 miles remained to be constructed to complete the scheme. Up to the end of March of this year a further 60,000 tons of limestone had been placed. At the present time six hopper barges are at work, and it is hoped to complete the training walls, which will extend up to points *E* and *F* in Fig. 2, in a few years.

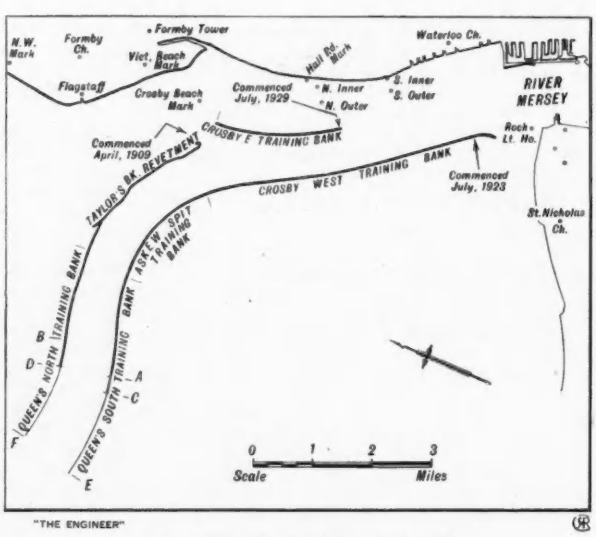


FIG. 2—LIVERPOOL BAY SEA CHANNELS

REPAIRS TO GLADSTONE-HORNBY LOCK

The impounded portion of the Mersey Docks and Harbour Board's northern system of docks, in which the water is maintained at the required level at all states of tide by pumping, extends from the Sandon half-tide dock at the south end to the Hornby dock at the north end, and includes the deep-water docks of Huskisson, Canada, Brockle-

* "Engineering Works for the Improvement of the Estuary of the Mersey." James Andrew Cashin, M.I.C.E. Maritime Paper No. 13, appearing in the *Journal* of the Institution, of May, 1949

bank, Langton, Alexandra and Hornby. The importance of the Gladstone-Hornby lock lies in its function of connecting this group of docks to the non-impounded Gladstone system of docks and thereby to the River Mersey through the Gladstone river entrance

FIG. 3—COFFERDAM AT SOUTH END OF GLADSTONE-HORNBY DOCK

lock, which can be negotiated by large vessels at almost all states of tides.

This lock was constructed in mass concrete and was opened with the Gladstone dock system in 1927. It has a width of 89ft 3in and a length of 740ft between emergency caisson checks, the level of the sill being 10ft below Liverpool bay datum.† Three pairs of

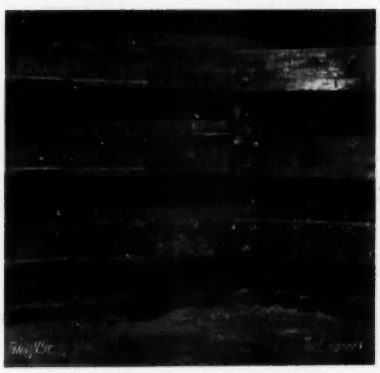


FIG. 4—DETAILS OF STRUTS MEETING WALINGS

mitring timber gates are provided, dividing the lock into compartments of 350ft and 295ft, or 645ft overall, to suit the size of passing ships. The gates are designed so that the water immediately south of the lock may be maintained at a level of about 30ft above bay datum.

Since its opening no major repairs of any nature had been required, but during the German air raids the lock received extensive damage. The east wall was struck with one or more bombs and a length of about 80ft collapsed inwards. The damage was increased by a delayed action mine, which exploded below water and shattered the south sill and lock floor. From visual inspection and divers' reports it was obvious that the lock would have to be dewatered before complete repairs could be carried out. This was not possible during wartime, but divers and dredgers removed a portion of the debris and cleared a 60ft passageway through the lock.

After the war, work was commenced on the drying out of the lock. The north end was sealed by a ship caisson and the south end with a steel sheet pile dam. The dam was of considerable proportions, being 150ft long, 60ft wide and 50ft deep. The skin piles were Appleby-Frodingham No. III section, 60ft long, and were supported by twelve tiers of Douglas fir timber walings ranging in size from 12in by 12in to 16in by 16in. These walings were supported by a steel framework of struts, lacing members and vertical piles. A general view of the dam, taken from the south-west knuckle of the lock, is shown in Fig. 3.

The struts varied in length from 13ft to 85ft and were fabricated from two 12in by 3½in channels with ⅜in thick batten plates. The lacing members which restrained the struts in a horizontal direction were also pre-fabricated, being constructed from 12in by 5in rolled steel joists; the vertical members were 15in by 5in steel joists. As the internal bracing had to be fixed below water, considerable thought was necessary in the design of the connections of the various members. The connection between the steel struts and timber walings was simplified by introducing a short timber transition member into the ends of the strut, which transferred the load from the waling to the steel member by bearing against a bracket riveted inside the strut. Fig. 4 illustrates this connection.

Where the horizontal struts, vertical king piles and horizontal diagonal lacings met,

FIG. 6—KING PILE LACING AND STRUT CONNECTION

a sound yet simple connection, which is shown in Fig. 6, was evolved. In the steel strut a guide box was formed, which guided the king pile and prevented it from twisting out of position. A 2in diameter forged steel pin was inserted through both sides of the strut and through the web of the 15in by 5in king pile. Brackets were attached to the lacings so that a box was formed when the lacings were placed on the struts, and to

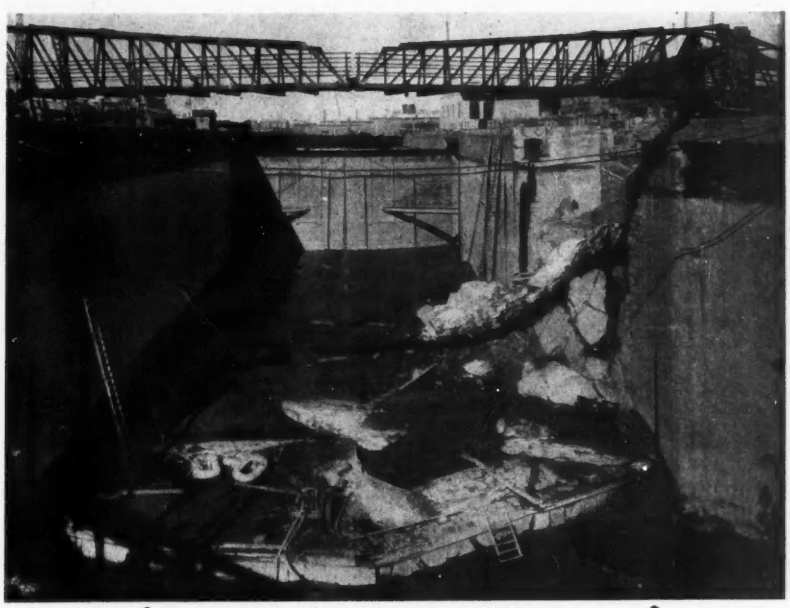


FIG. 5—DAMAGED LOCK VIEWED FROM SOUTH END

† Liverpool bay datum is 10ft below the sill level of the Old Dock Sill, and is equal to −14·54 O.D.

make the connection the divers were only required to fit timber blocks into the open ends and the connection was completed. By these means the members were held in all directions. After divers had completed the internal bracing of the dam the lock was dewatered, partially by running off through culverts connected to the River Mersey and then finally by pumping, using five 6in electric pumps.

A proportion of the back fill of the lock walls was removed previous to the dewatering operation. An investigation into the stability of the walls indicated that this precaution was desirable; the fill was removed to a depth of 14ft and a bottom width of 18ft along each side of the lock for about three-quarters of its length. With the removal of the water and residual mud the full extent of the damage was ascertained, and the breach in the wall was found to be 80ft long and 27ft deep, thus leaving a depth of 25ft of the old wall undamaged. The parts of the original wall adjacent to the breach were badly spalled, and it was therefore proposed to cut the old wall so that where the new concrete joined the old there would always be a reasonable thickness of new concrete facing. The condition of the lock shortly after dewatering is shown in Fig. 5, which was taken from the cofferdam at the south end.

Fig. 7 shows the reconstruction work in progress, from which the method of construction in lifts of about 4ft can be seen; the type of shuttering used is clearly shown. The soldiers were held by a bolt at the top and bottom of the previous lift, and at the top of the new lift a bolt, plate washer and nut were cast into the concrete, to provide a support for the shuttering of the next lift above. Thus the shutter was simply moved up the wall as the concreting proceeded, always being supported by the bolts in the previous lift. Precast units used to form the arch of the pipe culvert can also be seen in the figure.

It was found that the south sill was so badly damaged that a complete new sill was required, together with a new floor in the damaged area. When excavation for this work was commenced, trouble was experienced due to water and sand seeping into the lock bottom. Therefore, in order to obviate any further difficulty the area to be reconstructed was divided into sections by driving rows of 17ft long steel sheet piling. Three rows of piling were driven right across the lock with cut-offs driven between them to form six rectangular sections. After this had been done, each section was excavated and concreted separately, the piling being incorporated in the work. The new sill was faced throughout with granite in place of the 14in by 7in wearing timber used on the old sill, and special attention was given to forming a satisfactory joint at the pivot stone on the east side, where some damage had occurred.

The cost of repairing the Gladstone-Hornby lock was about £200,000, and the work was carried out by direct labour, the Board's engineers being responsible for the design and execution of the work.

(To be continued)

Iron and Steel Institute

SUMMER MEETING IN NORWAY

No. III—(*Continued from page 696, June 24th*)

ON Saturday morning, June 4th, on awakening members found the "Venus" sailing up the Sognefjord amidst scenery even more remarkable than that of the Hardangerfjord. Frequent side fjords or valleys gave glimpses of a distant hinterland sometimes glacier-covered. Soon after 10 a.m. the ship anchored off Ardal and parties were taken ashore by boat.

For the first and only time on the whole trip the organisation for this day broke down. It came about in this way. About half the members and most of the ladies were due during the morning to be driven in coaches and cars to the Heirnosi viewpoint, a spot about 3000ft high, reached by a drive along a valley and a steep climb, zig-zagging across the face of the mountain. All went well during the drive of about 7 miles along the valley. It was a spectacular ride in itself. For the road, only recently made, includes at a point where the shoulder of a mountain presses precipitously out into a lake, a long tunnel driven through the rock. The trouble arose on the subsequent climb. Here the gradient, though steep, is regular. But there are frequent hair-pin bends, at many of which coaches and even cars had to reverse in order to get round. It was rumoured—and it is a rumour that we can well believe—that there are forty such bends in the climb. It is obviously a trying place for motor vehicles. About one-third of the way up, the leading car "conked" holding up the whole convoy, and when after an interval it was set going again, the following car failed to start. That difficulty overcome, though much time was lost, the leading coach chose to repeat the performance when about two-thirds of the way up and in a position such that no other vehicle could pass. These mechanical troubles were not serious. If we may venture a guess they arose as a consequence of the very common, but not altogether wise, practice of placing the petrol pump under the bonnet. Should the engine then become somewhat overheated petrol may vaporise in the pipes and the pump temporarily go out of action. Eventually all vehicles with the exception, we believe, of one, reached the top, though a number of members climbed the final third by muscle power and at least one lady is reported to have come up almost the whole way on foot. But the time schedule had been

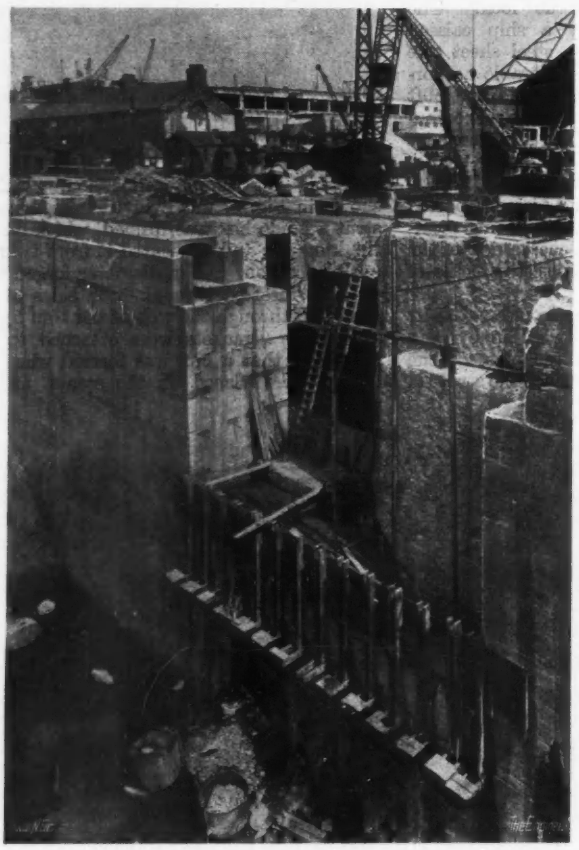


FIG. 7—REPAIR OF BREAK IN EAST WALL

ARDAL ALUMINIUM WORKS

put seriously out of gear, and the visit to the same spot by a second party in the afternoon had to be cancelled.

The view from the top towards some of the highest mountains in Norway was found to be very fine indeed. But it was not the only reason for taking the members to the spot. Higher still and some kilometres further on along a side valley there is a reservoir. Owing to snow on the road it was not possible to reach it. But close to the Heirnosi viewpoint there are the end of the tunnel from this reservoir and the headworks of the pipe-line leading down to the power station below of the A/S Ardal aluminium plant. There is little to be seen above ground except the valve house at the end of the tunnel from the reservoir. But below ground a cavern has been excavated. Thence a sloping tunnel has been driven through the mountain side down to the power station, to accommodate the penstock pipe. Within the cavern at the top there are to be seen two butterfly valves in the pipe, one operable electrically from the power station and the other arranged to close automatically should the pipe-line burst or any accident occur which might release the water. There is also to be seen a big hoisting gear driven by an electric motor. It operates ropes capable of drawing up a carriage from the power station and was used for the erection of the pipe-line.

Later in the day when the party had descended and a hastily organised sandwich lunch had been taken at the Ardal aluminium works, members were able to visit the underground power station, a photograph of which is reproduced above. It is a very impressive hall lit by daylight lamps in the roof and contains five Voith Pelton wheels driving A.E.G. generators, each generating 35,000kVA at 6300V, and operating under a head of about 3000ft. The reservoir above provides a storage of 9·5 million million cubic feet. It is, of course, the availability of this great amount of power that has brought the great aluminium plant to this somewhat remote spot at the head of a lake which cannot be reached by sea-going ships.

In the afternoon a visit, somewhat hurried owing to the effects of the delays of the morning, was made to the aluminium works. The erection of these works was started during the German occupation by A/S Nordag, a German-owned company. This company was formed to develop a large aluminium industry in Norway, but owing to a number of factors (not least among which, we suspect, were the activities of the resistance movement) it was only at a few places that work on individual plants made much headway. A/S Ardal Verk was founded in 1946 to take over the plant. The works are connected over the new road, already mentioned, to the head of the Sognefjord, seven miles away, and Lake Ardal provides another means of transport. The Germans, indeed, built a short narrow-gauge railway to connect the downstream end of this lake with the quay on the Sognefjord, but this railway appears to be no longer in use.

The works has two big pot-houses measuring 150 by 380 yards each. One is already equipped with some 170 electrolysis cells operating at 30,000A to 32,000A and 5V. The anodes are of the Soderburg type in aluminium casings. The other, not yet fully equipped, is expected to come into operation this year. The necessary alumina comes from Canada. The metal produced is 99·5 to 99·8 per cent pure. It is drawn off at intervals into travelling vacuum pots in which it is carried to the smelter house. Here in five resistance furnaces of a capacity of 15 tons it is degassed and refined. The furnaces are of the tilting variety and the metal is either cast into open ingots or by the bottom freezing process into flat slabs. The pouring of such a slab was observed by the members. At full capacity the works will produce between 20,000 and 24,000 tons of aluminium annually. It is intended later to start the production of aluminium alloys.

On their way back to the ship members were able also to see the electric pig iron plant at Ardalstangen, with its quays on the Sognefjord. It is controlled by the same company and as planned by the Germans was intended for the production of alumina. After the war this plan was changed and the plant is now producing vanadium iron, the raw materials for which are supplied by Christiania Spigerwerke and the Bremanger Power Company.

The whole arrangement of the plant, as might be expected from one so recently built, is very modern. There is a quay some 200m long against which sea-going ships up to 12,000 tons burthen can moor. Grab cranes can lift raw material directly from the holds and deliver them to a bunker and weighing machine. Thence a transporter can distribute them to any one of a number of stock bunkers in a covered bunker house of large dimensions extending along the quay side. From these bunkers the material can be lifted by grabs on to a conveyor installation serving a crusher and mixing plant and leading to an electric sintering plant whence, while still hot, the material is discharged to a ball grinder. The sinter so prepared contains 64 per cent iron. Much interest was shown in the single furnace at present operating (out of three likely to be eventually installed). It absorbs 15,000kVA and is equipped with Soderburg electrodes, the paste for which is made on the premises. The furnace is totally enclosed. Six chutes from above feed to it the mixture of sinter, limestone, Swedish ore and coke, and the gases are drawn off through a single large pipe. We understood that these gases are at present discharged to atmosphere, but that consideration is being given to methods of utilising them. For, owing to the fact that the furnace is electrically heated little more coke is required than is necessary for the reduction of the ore, and the gases are consequently very rich by ordinary blast-furnace standards in carbon monoxide.

The furnace is tapped into a ladle and the metal then teemed into chill moulds on a casting machine arranged like a chain conveyor. As the conveyor moves the moulds cool in the air and are lifted to an automatic discharge point whence the pig falls into hopper wagons for transport to the quay.

Members returned to the ship for dinner and in the evening a dance was held on board.

POT-HOUSE OF ALUMINIUM WORKS

ARDAL UNDERGROUND POWER STATION

BALESTRAND

On Sunday morning the "Venus" sailed slowly down the fjord to Balestrand, where luncheon was taken ashore at the Hotel Kvikne. It was the farewell luncheon. For though the ship was still due to call at Bergen very early the following morning it was also timed to leave that harbour by 8 a.m. At

the luncheon a toast was drunk to Mr. Anthony Post, of the Institute staff, who had been particularly responsible for the organisation of the trip and whose voice had been heard every day over the ship's broadcasting system giving instruction and advice with a clarity worthy of a B.B.C. announcer. Sir Andrew McCance also called upon representatives of a number of countries who had taken part in the trip to speak. Professor Cohen, of the Massachusetts Institute of Technology, spoke for the United States; Dr. Grönblom, of OY Vuoksenniska A.B., for Finland; Baron Walckenaer, President of the Société Métallurgique de Normandie, for France; Hr. Ingen Housz, President of the Royal Dutch Iron and Steel Works, for Holland; Victor de Chavarri, Marques de Triano, President and Chairman of Altos Hornos de Vizcaya S.A., for Spain; M. Sunstrom, President of Gunnebo Bruks Aktiebolag, for Sweden, and Dr.-Ing. Durrer, managing director, L. de Roll Iron Works, Ltd., for Switzerland.

Lastly, Sir Andrew McCance expressed thanks, on behalf of all those who had taken part in the trip, to their Norwegian hosts. He hoped the Institute might have the privilege soon of welcoming the Norwegian Metallurgical Society to Britain. Mr. Schjelderup briefly replied, and soon afterwards, the weather having turned to rain, members returned to the ship.

On the way down the Sognefjord the ship made a small diversion in order to anchor for an hour opposite Hoyanger, in the Hoyangerfjord. Here there is a works of the A/S Norsk Aluminium Company. It was first built in 1916, and the output is about 9000 tons of aluminium annually. Perhaps the chief interest in the plant lies in the method used to produce alumina from bauxite. The process was originally developed by Professor Pederson. Bauxite limestone and coke are fused in 3000-kW smelting furnaces producing calcium aluminate and a high-grade electro-pig iron. The calcium aluminate is reduced to powder in ball mills and treated with a solution of sodium carbonate, changing to sodium aluminate. This salt is then altered to aluminium hydrate by means of carbon dioxide, and by filtering and calcining alumina is obtained in the form of a dry white powder, The alumina factory produces 17,000 tons annually. The process is applicable to ores other than bauxite.

No visit was made to this works and unfortunately the weather having become misty, it was difficult to distinguish very much ashore while the ship was anchored.

Return to Newcastle

During the night as the ship sailed round the coast to Bergen, any members who woke up noticed that for an hour or so a considerable roll developed. For, over a distance of some 20 miles, the ship passed out into the open sea before reaching the shelter of those many islands that fringe the mainland coast. On Monday, after the ship had left at Bergen those members of the Reception Committee and others who, at various places, had joined the party on board, breakfast was taken under calm conditions as the ship sailed under the shelter of islands to the westward. Once, however, the coast was left behind and the open sea was reached, a pitch and roll developed. There were appreciably fewer to take lunch than had eaten breakfast, fewer still to take tea, and by dinner time the dining rooms were very far from crowded. But by breakfast time the following morning the ship was under the lee of the English coast.

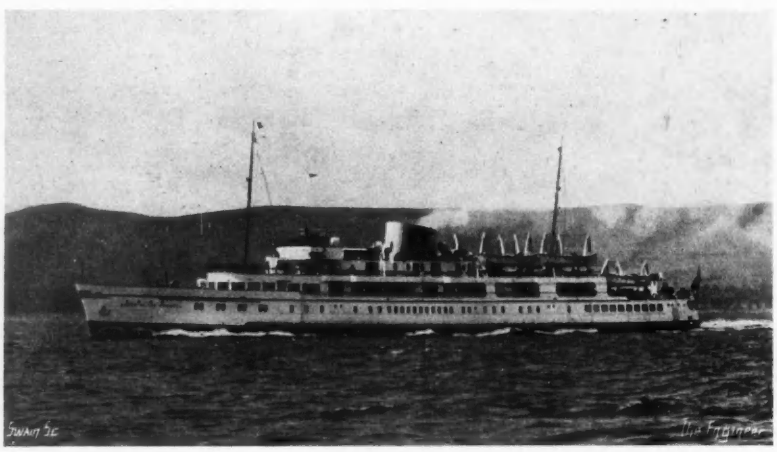
And so carrying with them memories of Norwegian hospitality, of Norwegian works, and of stories of the resistance movement that generated admiration for a people who, even if their country was occupied by the enemy, were, for all that, never demoralised or really defeated the members of the Iron and Steel Institute broke up into parties to go their different ways to London, Glasgow, Sheffield, South Wales and other parts of this country.

Two New Cross-Channel Packets

By G. W. TRIPP, O.B.E., F.C.G.I., M.I.C.E,

THE ravages of war sadly depleted the tonnage of British shipping and no class was more severely hit than that engaged on cross-channel work. From time to time we have been able to describe new vessels that have been built as replacements, but none has been deserving of greater praise than the new "Maid of Orleans," which made her inaugural cruise on June 22nd, being placed on the Folkestone services to the Continent on the following day. She replaces a vessel bearing the same name, one of the most popular of the Southern Railway steamers, which was built in 1918 by Denny Bros. and Co., Ltd., and had a tonnage of 2386 gross; a length of 341·2ft; breadth 42·1ft, and a depth of 16ft. She was driven by four steam turbines, with single reduction gear, giving her a speed of 23·5 knots. Unfortunately, she was mined in June, 1944, and became a total loss.

Although of about the same length as the ship she replaces, the new vessel as shown in the accompanying engraving is considerably bigger,



"MAID OF ORLEANS"

as the following dimensions will show: length over-all, 341ft; breadth, moulded, 50ft; depth, moulded to main deck, 18ft; draught when loaded, 12ft 6in; tonnage 3777 gross, 1670 net. She is propelled by two sets of geared turbines, developing a total of 11,000 s.h.p., which impart a speed of 22 knots. For harbours that are awkward of access turbine steamers have frequently suffered from the fact that their power astern is very restricted. Attention has been paid to this in the new "Maid of Orleans," and she is fitted with high power astern turbines, which give her a speed of 17 to 18 knots. She is a good-looking ship, with raked and rounded bows, a short streamlined funnel and two masts. She has a bow rudder to enable her conveniently to enter port stern first, and this as well as the balanced rudder aft is operated by a twin motor electro-hydraulic steering gear manufactured by Brown Bros. and Co., Ltd.

The main machinery, constructed by the builders, as shown in the accompanying drawing consists of two sets of Parsons geared turbines, with a combined output of 11,000 s.h.p. at 275 r.p.m. Each unit consists of an h.p. ahead turbine of impulse reaction type and an l.p. ahead turbine of all-reaction type. An h.p. astern turbine of all-impulse type is incorporated with the h.p. ahead turbine, and an l.p. astern turbine of impulse reaction type is incorporated with the l.p. ahead turbine. The turbines drive the main shafting through single reduction gears of double-helical involute type. A single collar Michell thrust block of line contact is incorporated in each gearcase. The main shafting is supported in Cooper split-roller bearings. The twin screws are of Denny Bros. "Aquadal" design, having a diameter of 9ft 10in and a pitch of 9ft 10in. They were manufactured by Bulls Metal and Melloid Company, Ltd. The condensers are of Weir two-flow regenerative type, fitted below the l.p. turbines, suitably supported on springs. They are arranged to work in conjunction with a Weir closed-feed system, including closed feed controllers, "Maxivac" three-stage air ejectors, electric motor driven two-stage vertical extraction pumps and turbo-driven horizontal centrifugal feed pumps.

Electric current at 225V is provided for lighting, power, cooking, heating, &c., by two turbo-generators each of 300kW capacity, and one diesel generator of 250kW capacity. These have been supplied by Peter Brotherhood, Ltd., the dynamos being manufactured by Lancashire Dynamo and Crypto, Ltd. The turbo-generators are self-contained units, each with its own condenser, circulating water and extraction pumps, air ejectors and closed-feed controllers.

Steam for both main and auxiliary plant is supplied by two Foster Wheeler "D" type boilers at 250 lb per square inch pressure, with a temperature of 500 deg. Fah. at superheater outlets. The boilers are arranged to burn oil fuel on the closed stokehold system, and each boiler is fitted with six sprayers. The oil-burning equipment was supplied by Wallsend Slipway and Engineering Company and consists of duplicate electric motor-driven pumps, heaters and filters. Control of the boiler water level is provided by Weir Robot regulators and high-lift safety valves and self-closing main stop valves have been supplied by Cockburns, Ltd. Klinger double-plate type water-level gauges and "Igema" distant reading gauges are fitted. Pyrometers are available to indicate the steam and funnel gas temperatures, and a Malone CO_2 indicator is installed.

There are two main engine "Vertoil" lubri-

cating oil pumps, supplied by Drysdale and Co., Ltd. each capable of supplying the full requirements of both main engines, Serck oil coolers and Autoklean strainers are fitted, while a Sharples oil purifier is arranged for continuous purification. Among other supplementary plant may be mentioned an evaporator and distiller of 25 tons capacity arranged to evaporate fresh water and distil for boiler make up feed purposes; an oily water separator for dealing with oil bilge water; two electric motor-driven forced draught fans supplied by W. H. Allen, Sons and Co., Ltd., fitted in a separate compartment on the main deck; an electric motor-driven submersible emergency bilge pump in the boiler-room by Drysdale and Co., Ltd.; a Spanner Spiralflo boiler in the boiler-room for domestic steam supply, arranged to burn oil fuel by an automatic oil-burning unit; a sewage disposal system supplied by Adams Hydraulics, Ltd.

As illustrated above there is a large combined wheelhouse and chart room, in which will be found telemotor steering control for the stern steering gear. Steering and observation compasses are arranged in the wheelhouse while a telemotor control is arranged on each wing of the bridge for operating bow steering gear. All the telemotors were provided by Brown Bros. and Co., Ltd. A Marconi "Radiolocator" marine radar equipment has been provided, with the instrument in a convenient position in the wheelhouse. This equipment should be of infinite value in the crowded Straits of Dover, when visibility is poor. Among other navigational equipment may be mentioned a Fathometer echo-sounder, a Chernikeef electric log, Willet-Bruce automatic whistle control, Elliott type engine revolutions indicators, Siemens electric main and emergency engine telegraphs and docking and steering telegraphs, electric helm indicators, Clifford and Snell loudspeaking telephone and amplifier system, providing communication between bridge, forward and after decks and engine-room, Kent clearview screens.

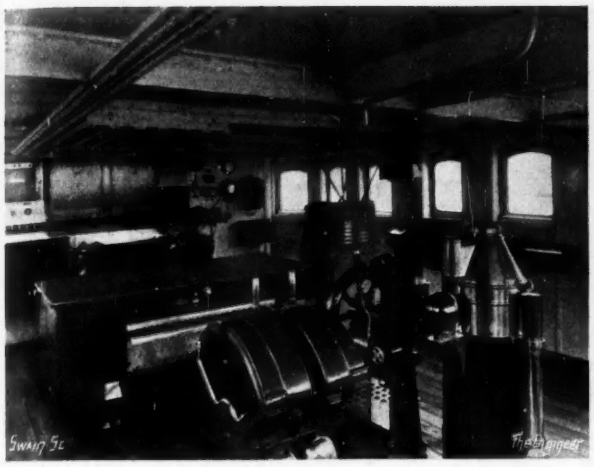
The whole vessel is ventilated throughout by plant designed and fitted by the Thermotank Company, Ltd. In going over the vessel it was noticed how pleasant the atmosphere was in the engine-room and boiler-room, as well as in all the public apartments.

This vessel can accommodate 1400 passengers, with a crew of seventy-six, while twenty-five to thirty motor-cars can be carried, as well as baggage and mails. The passenger accommodation is of a high order, and every effort has evidently been made to secure a maximum degree of comfort, while the amount of panelling is a special feature, different woods being used. In an illuminated alcove over the main staircase is a bronze equestrian statuette of Joan of Arc, while over the staircase in the third-class is a carved panel, also representing the maid after whom the ship is named. There is a large and comfortable observation lounge on the boat deck, two cabins-de-luxe equipped with writing-desk, dressing-table, lavatory, telephones, &c. On the upper deck a spacious restaurant can seat 118 passengers. The first-class smoke room and bar, are illustrated below and there is also ample sheltered deck space. On the main deck will be found a number of well-furnished private cabins, also third-class ladies' lounge and gentlemen's lounge, a bar and buffet, as well as a general third-class lounge, and smoke-room—indeed, the third-class accommodation is exceptionally good. On the lower deck are situated two first-class lounges for ladies and gentlemen respectively. The whole of the passenger accommodation is characterised by a degree of comfort that is usually associated with the ocean liner, and a noticeable feature throughout the ship is the absence of all pipes, girders and the like, all being hidden behind the tastefully selected panelling.

A combined electric windlass and warping capstan, and one independent capstan are fitted forward and two electric warping capstans are fitted aft. Winches operated by portable electric motors are provided for hoisting purposes in connection with the eight wooden lifeboats, one with a motor, six on the boat deck in overframe type Columbus davits and two on the bridge deck.

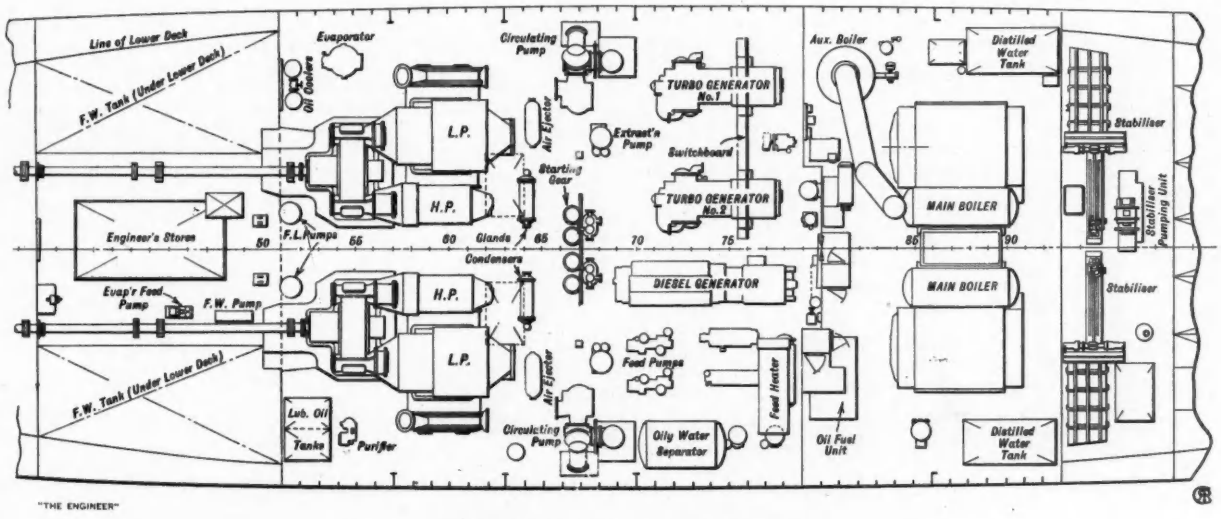
On going over this ship the absence of vibration even at full speed was noticeable, while another great improvement is the absence of smoke on the deck, a state of affairs that is ensured by the provision of a covered top to the inner funnel, the effect being to increase the velocity with which the gases are ejected from the funnel, thus forcing them sufficiently high to avoid the area of low pressure immediately abaft the funnel.

The occasion of the inaugural cruise did not



INTERIOR OF WHEELHOUSE

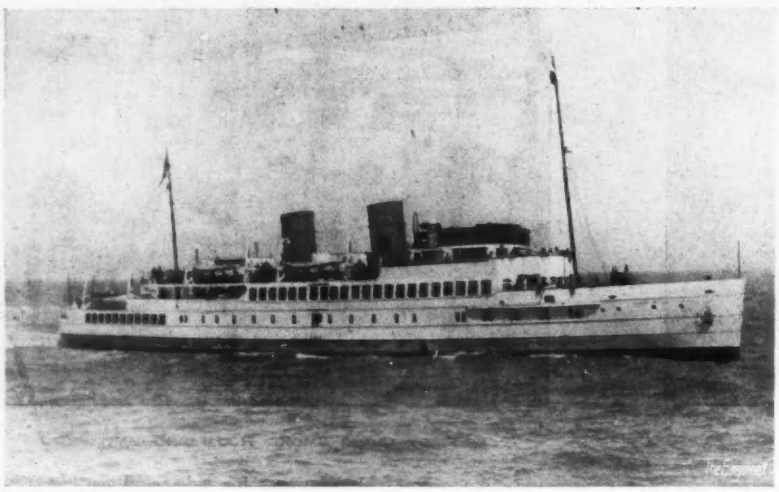
FIRST CLASS SMOKE ROOM AND BAR



PLAN OF ENGINE AND BOILER ROOMS

afford an opportunity of seeing the efficiency of the Denny Brown stabiliser, which has been fitted as the sea was in a very gentle mood, but it should prove of great value in rough weather in the Straits, as it has already shown its worth on the Southampton services.

There is little doubt that this, the latest addition to the fine fleet of the Southern Region of British Railways, will become as popular with the present generation as the former "Maid of Orleans" was with their fathers, even though they may perhaps be more exacting in their requirements.



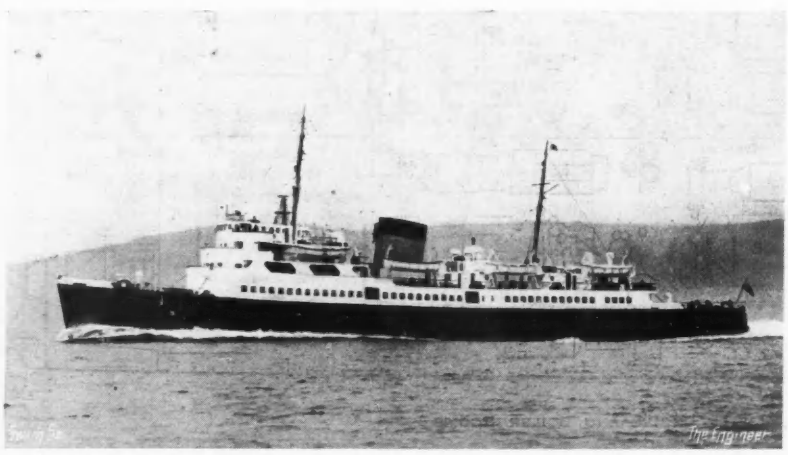
THE FIRST M.V. "QUEEN OF THE CHANNEL"

M.V. "QUEEN OF THE CHANNEL"

Of an entirely different character is the second vessel that has recently been put into service, a vessel that only sails for about four months out of the twelve, and is engaged on pleasure cruises. Before the war day excursions to the Continent had become a recognised feature in the programmes of the London pleasure boats, beginning with the conversion by the New Medway Steam Packet Company of two Admiralty mine sweepers, which were put on service in 1928 and 1929 respectively. The older London company, the General Steam Navigation Company, watched the venture and toyed with the idea of building a large cross-channel paddle steamer for this work. In the meantime the Medway Company, with the co-operation of William Denny and Bros., Ltd., boldly decided to build a motor vessel for this service, and in 1935 the "Queen of the Channel" appeared (as illustrated herewith), a good-looking yachtlike craft, which soon became popular, so much so that a larger vessel was ordered. The leading dimensions of the first "Queen of the Channel" were: length, 250·8ft; breadth, 34·1ft; width, 34·1ft; depth, 9·2ft; tonnage, 1162 gross. She was driven by two sets of eight-cylinder direct-acting diesel engines, which gave her a speed of 21·7 knots.

When the Medway Company invaded London with their ships, the London Company thought it high time to take serious notice, with the result that they obtained a controlling interest in the Medway company, which though maintaining their identity on matters of policy had to realise they were a subsidiary company. Unfortunately, two of the three motor vessels of the combined fleets were lost in the war, "Royal Sovereign" being replaced last year by a ship of the same name, which has already been described in this paper.*

"Queen of the Channel," like so many other good packets, was lost during the evacuation of Dunkirk, but has now been replaced by a vessel of the same name, flying the house-flag of the New Medway Steam Packet Company. As will be seen from the illustration above, she is a well-proportioned, sturdy craft of modern lines, perhaps not as graceful as her last namesake, which, as will be seen, was one of the prettiest craft of her day, but the new "Queen" is more in line with modern practice.



M.V. "QUEEN OF THE CHANNEL" ON HER TRIALS ON THE CLYDE

Built by William Denny and Bros., Ltd., she is more generously proportioned than was her predecessor, as the following dimensions will show: length (overall), 271ft 10in; length on water line, 264ft; breadth (moulded), 40ft; breadth (overall), 44ft; mean draught, 7ft 6in; tonnage, 1472 gross. On a steam II and III certificate she can carry 1362 passengers, and on a steam IV, 1536. She is driven by two sets of eight-cylinder Denny-Sulzer two-stroke cycle, trunk-piston, airless injection, port-scavenging engines, each developing 1500 b.h.p., which imparted to her a speed on trials of 18·98 knots. The passenger accommodation is of a high standard and the vessel may be called an all-weather one, having plenty of shelter deck, including a sun lounge 163ft long by 25ft wide, fitted with Lloyd Loom furniture of the latest type. In this will be found a cocktail and milk and snack bar. She has two dining saloons, the forward one seating seventy-six and the after one 114 people. There is a comfortable smoke-room on the promenade deck. All the auxiliary machinery is driven by electric motors, current being supplied by three 100-kW generators driven by Allen oil engines, and there is also an emergency 8-kW set. There is an electric windlass forward and an electric capstan at the after end. There are six lifeboats, four situated on the boat (or sun) deck, and two astern. The vessel is equipped with Marconi radio transmission, with a band repeating apparatus. There is a Decca navigator, and the whole ship is furnished throughout with mechanical ventilation. All cooking apparatus such as grills, toasters, coffee boilers, are electrically operated.

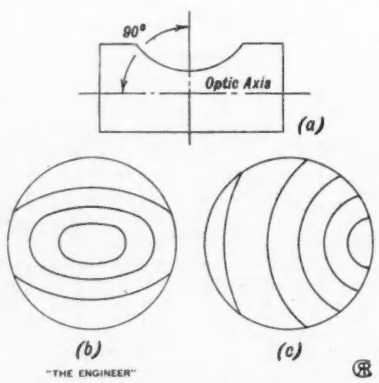
This vessel is employed on Channel cruises over to the French coast from Clacton, Chatham, Ramsgate and other coastal piers, and should prove a definite acquisition to the combined fleet; indeed, both the ships described in this article may be regarded as among the best in their respective classes.

* THE ENGINEER, Aug. 20, 1948, page 193.

Jewel Inspection by Polarised Light Microscope

IT is well known from experimental evidence that if artificial sapphire meter-bearing jewels are not cut in the correct manner, accelerated wear of both pivot and jewel will occur. To obtain maximum life, the jewel has to be cut so that the optic axis of the crystal is at right angles to the axis of revolution of the recess. It is therefore necessary for meter manufacturers to be able to check the orientation of jewels before use, an operation that may be conveniently carried out by means of the polarised-light microscope.

One method, well known to crystallographers, makes use of the pattern of concentric coloured rings intersected by a black cross which is formed when a sapphire crystal is viewed along its optic axis in the microscope. Although the results are precise, inspection by this means is cumbersome, since the jewels have to be held on edge and immersed in a suitable liquid of the same refractive index.



(*a*) Greatly enlarged diagram of bearing jewel showing optic axis and axis of symmetry.
(*b*) Pattern shown by correctly cut jewel.
(*c*) Typical pattern from wrongly cut jewel.

PATTERNS SHOWN IN POLARISED LIGHT MICROSCOPE

The main principle of the new method adopted

by the Development and Research Department of Crompton Parkinson, Ltd., is similar, use being made of a characteristic interference figure obtained when a jewel of correct orientation is viewed along its geometric axis in monochromatic light. It is then possible for the jewels under inspection to lie flat on the microscope stage and mounting on edge is unnecessary.

Typical interference patterns are shown diagrammatically herewith. As indicated in diagram (*b*) a correctly cut crystal is characterised by a pattern of ellipses concentric with the optical axis of the microscope. On the other hand, eccentric ellipses (*c*) indicate a wrongly cut crystal.

To facilitate jewel checking by comparatively unskilled staff, a special microscope was constructed for the observation of these oval interference figures from a number of jewels in quick succession.

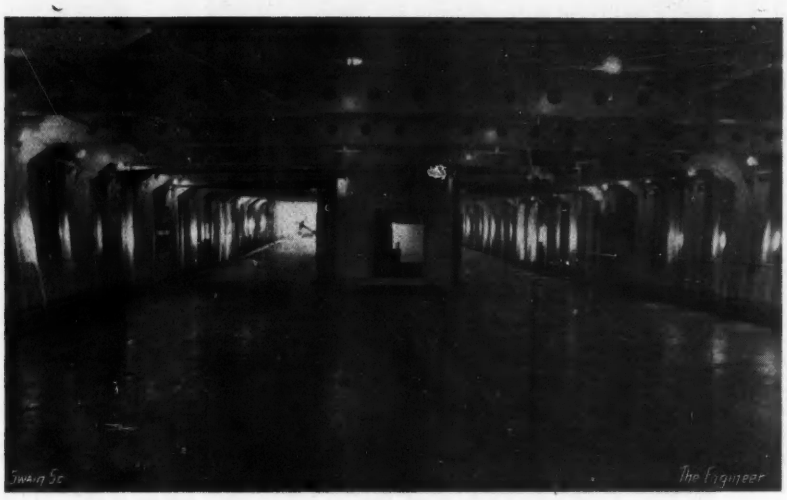
The jewels are held in a carefully machined recess in a brass plate spigoted to rotate accurately about the optical centre line of the microscope. It is essential that the jewels should lie flat in the mount, and this is fairly easily ensured if they are an easy sliding fit in the recess, and the depth is made such that jewels may be readily inserted and removed by tweezers.

Illumination is from a sodium vapour lamp which provides suitable monochromatic light, and it was found convenient to mount the lamp in a box upon which the microscope stands, the light passing upwards through a slit.

The microscope is of the conventional pattern with the following lens system :—½in objective, 1in focal length Bertrand lens and No. 2 micrometer eyepiece. Special gauges and collars ensure the correct relative positions of the tubes when working.

Jewels are acceptable only if the angle between the optic axis and the axis of rotation is between 80 deg. and 90 deg., all others being rejected. By suitable proportioning, it has been arranged that jewels for which the angle is less than about 78 deg. may be rejected at a glance and jewels with angles greater than 85 deg. may be similarly instantly recognised after a little practice. In border-line cases the eyepiece scale is used to measure the distance by which the oval figure is off the centre of the field of view, and this by reference to a calibration curve is a measure of the optic axis angle.

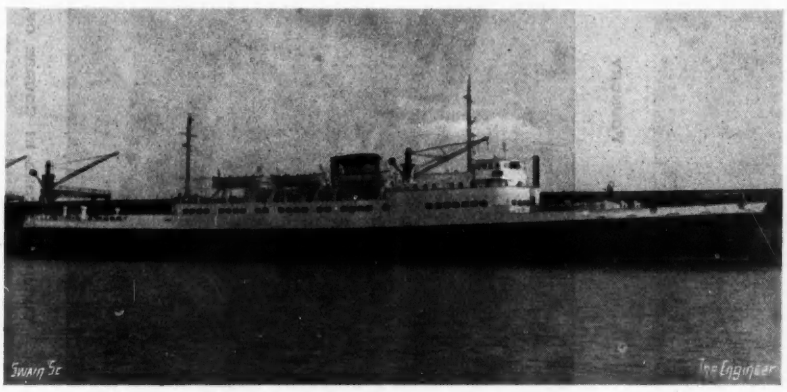
This technique is now in regular use by Crompton Parkinson, Ltd., as a production method of examination to ensure that only jewels cut correctly with respect to the optic axis may be used in the company's meters.



VIEW IN HOLD SHOWING ACCOMMODATION FOR MOTOR VEHICLES

The Cross-Channel Motorship "Car Ferry"

IN last week's "Seven Day Journal" we gave a short account of the cross-channel motor vessel "Car Ferry," which has recently been put into service on the Dover-Ostend route. We are now able to publish further information concerning this interesting ship. She was built for the Belgian Marine Administration by the S. A. John Cockerill, of Hoboken, near Antwerp, and was launched in September, 1948. Her principal dimensions and particulars are as tabulated on this page.



CROSS CHANNEL M.V. "CAR FERRY"

As will be seen from the accompanying engraving, the "Car Ferry" has a pleasing appearance, with her raked stem, cruiser stern and single funnel with two masts. In order to give extra manœuvrability two rudders, one forward and one aft, are provided. The ship is designed to carry about 100 motor vehicles in a garage with an area of about 10,000 square feet, which, as the accompanying engraving shows, covers almost the entire length of the ship. The minimum height of this hold is 10ft 2in, which permits, in addition to private motor-cars, the stowage of coaches, lorries, loaded goods trailers and caravans. The main hold is served by two large hatches, but for rapid loading and discharging the ship is furnished with a direct loading ramp at the stern. The Belgian Marine Administration at Ostend is designing and building a special loading ramp on a floating pontoon, and the hope is expressed that this will be in service next year, and that British Railways will be able to consider the provision of a similar arrangement at Dover.

In addition to her car-carrying capacity, the ship has excellent accommodation for 700 passengers. There are eighteen two-berth and eight four-berth cabins, and the public rooms include an attractive restaurant, seating about ninety persons, with a veranda bar.

The main propelling machinery comprises a twin-screw arrangement of Sulzer single-acting two-stroke engines each having a designed output of 4180 s.h.p. when running at 320 r.p.m. For the provision of power for the engine-room and ship, three auxiliary generator sets are used, which are Sulzer engines driving Laurence Scott dynamos. Steam is raised in a Cochran boiler fitted with a Laidlaw-Drew oil burner. The general ventilation of the ship is carried out on the Thermotank principle. A complete system of fire protection is arranged, which includes anti-fire shutters in the garage, as well as scuppers and fire detectors with water sprays and foam nozzles, also a carbon-dioxide fire extinguishing system.

Dimensions and Particulars

Overall length	373ft
Length between perpendiculars	364ft
Breadth, moulded	42ft 2in
Depth to shelter deck	28ft 8in
Draught, loaded	12ft 5in
Displacement in light condition	2250 tons
Deadweight carrying capacity	800 tons
Gross tonnage	2594 tons
Designed service speed	22 knots

Propelling Machinery

Type	Twin-screw Sulzer Diesel
Designed output, each engine	4180 s.h.p.
Normal running speed	320 r.p.m.

The navigation equipment includes a General Electric Company's radar equipment, a Chernikieff log, an Ardente master indicator and Kent clear-view screens. The steering gear for the bow and stern rudders is of the electro-hydraulic type, and was designed and fitted by Hastie's, of Greenock. The J. Stone's system of watertight doors is fitted throughout the ship.

In the course of his welcome to visitors to the ship at Dover recently, Monsieur Henri de Vos, the general manager of the Belgian Marine Administration, said that in designing the "Car Ferry," the Belgian authorities had in view the carriage of loaded goods vehicles, brought to Ostend, and taken from Dover, by road transport. He hoped that the Dover authorities would also consider the requirements of road as well as rail transport, and it might be necessary to provide a garage on shore for tractors as well as locomotive sheds. Monsieur de Vos deplored the fact that at present the number of visitors permitted to visit Belgium was, in view of financial restrictions, fixed at only one-third of the total number of visitors in 1947.

TRAFFORD PARK WORKS OF METROPOLITAN-VICKERS ELECTRICAL COMPANY LTD.

ELECTRICAL AISLE

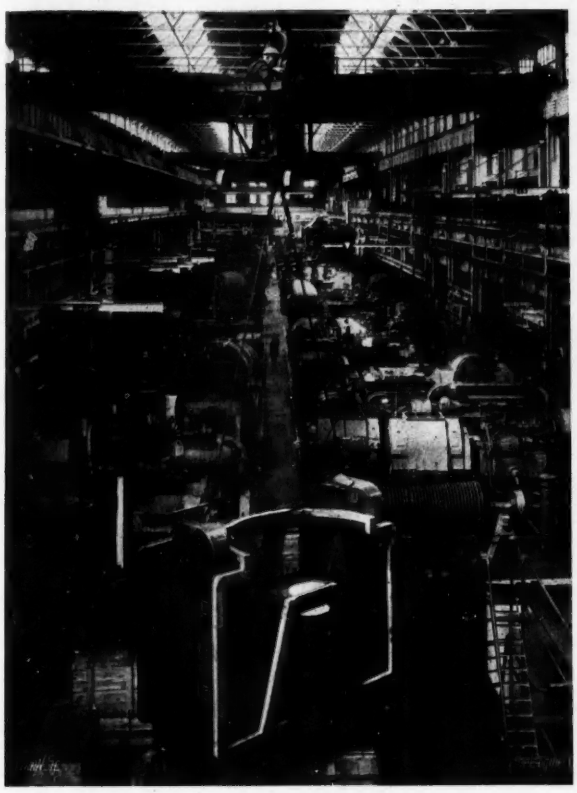
TANK SHOP

FOUNDRY

TURBINE ROTORS IN COURSE OF MANUFACTURE

Jubilee of Metropolitan-Vickers Electrical Company, Ltd.

ON July 10th next, the Metropolitan-Vickers Electrical Company, Ltd., celebrates the jubilee of its foundation; and during the past week and next week, friends of the company, customers and suppliers, advisers—all in fact who have had relations with it—are being or have been invited to visit the Trafford Park Works. We ourselves, in company with other representatives of the Press, had the opportunity to see the works last week, and in accompanying engravings we illustrate some of the shops which we saw.



MECHANICAL AISLE AND TURBINE TESTING SECTION

It is a remarkable tribute to the foresight of the first planners of the factory that the original buildings—the main machine shops and the two main buildings to the east which were originally the iron and steel foundries, and have now become the iron and brass foundries, transformer shop and forge—still serve adequately for the much larger products of to-day.

The company was founded in 1899 as the British Westinghouse Electric and Manufacturing Company, and set up its works at Trafford Park, which was then amidst rural scenery. At that time it had the benefit of drawing on the experience of its parent Westinghouse Company in America. But the early days of electrical engineering in this country were far from easy ones, and even survival seemed to be in doubt at times. However, by the time war broke out in 1914 the company was firmly established.

In 1919, during a brief association with the Metropolitan Carriage, Wagon and Finance Company, and Vickers, Ltd., the company's present name was adopted, without important change to its organisation and without any break in the continuity of its traditions, achievements and progress. Some association was still maintained with the Westinghouse Company of America, but upon fairly equal terms of exchange of manufacturing and research information. Ten years later Associated Electrical Industries, Ltd., was formed, associating the activities of Metropolitan-Vickers, the British Thomson-Houston Company, Ltd., Ferguson, Pailin, Ltd., and the Edison-Swan Electrical Company, Ltd. This association still continues, extended by the inclusion of some subsidiaries. Broadly speaking, it may be described as providing for exchange of information and some combination of resources, while leaving each main company separate in its activities and practically unchanged in its organisation. With this development the technical liaison with the Westinghouse Company of Pittsburgh was changed to one of somewhat similar character with the General Electric Company of Schenectady, U.S.A.

From the beginning, the company undertook a wide range of manufacture, including plans for electric power generation and transmission; railway, tramway and industrial electrification; relays, meters and instruments. In all these sections and in others subsequently added the company has made notable contributions to the progress of the industry. On the mechanical engineering side, for example, the multi-exhaust principle in steam turbine design and the practical application of regenerative feed-heating in power station plant have been major contributions to improved efficiency in power generation. The Metrovick 105,000-kW turbo-alternator set installed in 1935 in the Battersea power station is still the largest generating unit in Europe. Last year the company completed the first British hydrogen-cooled generator, a 60,000-kW set now in the Littlebrook (Kent) power station. Metrovick "Beryl" jet engines are used in the first fighter flying-boat, the Saunders-Roe "SR/A1," and established a mile-a-minute record in climbing speed in a Gloster "Meteor," while in the associated development of gas turbines a Metrovick 2500 h.p. unit was the first to be applied to ship propulsion, in the M.G.B. "2009." Another unit is being built for a turbo-electric locomotive for the British Railways, a 2000-kW gas-turbine generator set has been built and installed in the company's works power station, and a 15,000-kW set is being built for the Stretford power station of the B.E.A.

On the electrical side the company developed a 132,000-V transformer and switchgear for the Victoria Falls Power Company's system in South Africa; it later provided much of the equipment of the British "Grid," and recently has supplied a large 220,000-V transformer for Holland. The development of continuously evacuated high-vacuum high-voltage apparatus, based upon original work of the company's research department, has had important consequences, including the construction of powerful X-ray apparatus, electron microscopes, and the recently produced twin-tank vacuum coating unit for the deposition of thin films for special mirrors, the "blooming" of optical lenses, and other applications.

The company was one of the first to establish principles, the value of which is now widely recognised; in the training and selection of apprentices of all grades by merit; the payment of wages during training instead of requiring a premium; the allowance of time for technical education; and the planning of courses to give comprehensive and well-balanced experience. About 1000 trade apprentices and 500 "College" and "School" apprentices are in training at a time.

Labour problems have troubled the company remarkably little. It is a proud claim that no important industrial dispute or work stoppage has originated in Metrovick factories. In this matter also the company's policy of providing for discussion and co-operation has undoubtedly made a valuable contribution. The works committee at Trafford Park was set up even before such organisations were recommended by the Whitley Commission; the staff committee was established about the same time and both have had a great influence for goodwill and efficiency.

In two world wars the company has been called upon for special services. In the war of 1939 to 1945 the most extensive enterprise, and most different from the company's normal work, was the building of heavy bomber aircraft. Starting with a project for merely assembling, the company soon undertook the complete

MOSLEY ROAD WORKS—MOTOR DEPARTMENT TEST BED

manufac[illegible] of aircraft except for the engines. The first product was the twin-engined "Manchester," But it was almost immediately superseded by the four-engined "Lancaster," of which more than 1000 were completed before the end of the war. For this work a new factory was built in 1939, having main bays 100ft wide for the aircraft assembly; in the following year it was trebled in size, giving a total floor area of 800,000 square feet to meet the demand for thirty bombers a month. Since the war, this factory, the Mosley Road Works, has been re-planned, mainly for the large-scale manufacture of industrial motors. The development and manufacture of radar equipment, first for the Air Ministry and later also for the Admiralty and the War Office was undertaken. Following on a request for high-power valves the company made the first radar transmitter ever commercially manufactured; these were for a chain of twenty stations which were placed round the coast of Britain to give early warning of enemy raiders and which played an important part in the Battle of Britain by making it possible to conserve our fighters. A mass-production order for 500 transmitters followed immediately, and later complete sets of many different types were produced in large quantities. An interesting sequel to this work has been the production of radar equipment for merchant ships.

Many other items of war equipment were also produced on a large scale. One item deserves special mention. It is the application of "Metadyne" control to the power control of guns. This method of control, using a power amplifier having a ratio of up to 10,000 to 1 with a very rapid response, enables large forces to be applied with great accuracy and extremely small time lag in response, to small initial "signals." It proved of great value in rapid gun laying in response to predictor readings and to the stabilisation of platform mountings on board ship. Equipment on similar principles is now finding important industrial applications.

The company now has fifty years of useful work behind it, fifty years of varied experience. All engineers will hope that its next fifty years will see great developments made and that the production of goods for peaceful purposes will not again be interrupted by the need to answer the country's call for munitions and equipment for war.

G.E.C. Research Laboratories' Conversazione

LAST week, from June 21st to 23rd, the research laboratories of the General Electric Company, Ltd., held a conversazione, which was arranged to give representatives of all branches of the electrical industry, including universities and research establishments, an opportunity to see the laboratories at work. We were among the guests who attended the conversazione on Wednesday, June 22nd. Although the time available allowed no more than a glimpse at the activities of a few of the seventy-odd sections into which the functions of the laboratory are divided, the visit served to indicate the wide scope of the research work and the magnitude of the effort upon which the company spends £1,000,000 annually. Our tour also revealed ample evidence of the enthusiasm and initiative which has animated this research organisation under the inspiration of its first director, the late Sir Clifford Paterson.

It may be recalled that the laboratories were conceived in 1916, but the work was delayed by the first world war and the formal opening, performed jointly by Lord Robert Cecil and Sir J. J. Thomson, did not take place until February 27, 1923. To-day the laboratories cover a floor area of 200,000 square feet and employ a staff of 1372, including 286 scientific members. An aerial view of the buildings is reproduced herewith.

In general the object of the research organisation is to provide a scientific service for industry. For this purpose every factory and technical department in the G.E.C. organisation requiring the collaboration of research is represented by a group of workers at those laboratories. There are some thirty-four of these groups. In addition there are a number of service groups of analytical chemists, X-ray workers, spectroscopists, consulting engineers and statisticians, whose work is of interest in various branches of electrical engineering and whose services are available to all members of the G.E.C. organisation.

Attached to certain research groups there are try-out units in which the first production experience of new manufactures is obtained and where practical expression is given to the methods evolved in the laboratories of improving quality and reducing costs. The functions of these try-out units is not confined to making prototypes for providing the factories with production data. For example, during the war try-out units filled a gap in the nation's reserves of experience in the production of valves for centimetric wavelengths.

AERIAL VIEW OF G.E.C. RESEARCH LABORATORIES, WEMBLEY

Synthetic Sapphire

Before the war synthetic sapphire bearings, which are widely used in electricity meters and watches, were imported into Great Britain from Switzerland and Germany. With the drying-up of these sources of supply development work was started in 1940 in the research laboratories and successful manufacture was eventually undertaken by the company.

Some aspects of this work were seen during our tour, when the equipment demonstrated included a traditional type of Verneuil furnace for growing large pieces of sapphires known as "boules." These "boules" are single crystals of alumina and are produced by allowing a fine stream of aluminium oxide powder to fall vertically from a hopper, and to pass through a furnace where it is fused by a very hot oxy-hydrogen flame. The "rain" of fused alumina particles is collected on a fireclay support immediately below the furnace. For use in meter and watch bearings, the "boule" is then cut to size as required.

This cutting process is wasteful, and the laboratories were responsible for developing a new automatic apparatus for growing sapphire in the form of long, slender rods of circular cross-section. Cutting jewel blanks from rods such as these is a much simpler operation than that involved in the treatment of the traditional "boule."

A general view of the automatic apparatus, which is a refined form of the Verneuil furnace, is reproduced herewith. The sapphire rod projects upwards through a hole in the base of the cylindrical glass-walled furnace. As the rod grows by deposition of fused aluminium oxide on its upper tip, the lower end of the rod is moved vertically downwards by a geared electric motor. This motor is operated automatically in such a way as to keep the tip of the sapphire rod at the same level in the furnace. This result is achieved by focusing the image of the white-hot tip on to a photo-electric cell. Any change in the position of the tip causes a change in the photo-cell current, which is amplified electronically and used to start the motor in the correct direction to restore the tip to its correct position relative to the oxy-hydrogen flame in the furnace.

This process continues automatically as long as the hopper remains charged with aluminium oxide powder and as long as the flame is maintained in the furnace. Production of a rod of uniform shape depends upon accurate control of the flame and on the controlled gentle vibration of the hopper to produce an even "rain" of fused powder.

Synchrotron Vacuum Chambers

Development work in hand for the Atomic Energy Research Establishment, under the auspices of the Ministry of Supply, includes the provision of the vacuum chambers or "doughnuts" for three synchrotrons designed to accelerate electrons to energies of 30, 120 and 300 million electron volts respectively.

The making of these "doughnuts," including the process of forming of side stems, as demonstrated during our visit, is a good example of the glass blowers' art. In particular, the fabricating of the 30MeV doughnut is interesting inasmuch as it is made from the flat screen end of a cathode-ray tube. The neck of the tube is conveniently held in a chuck, while the tube is rotated about its axis during the fabrication of the hollow circular annulus which forms the vacuum chamber, as indicated

in one of the photographs reproduced herewith.

Powder Metallurgy

Powder metallurgy, which is finding increasing application in industry, was used in the development of Heavy Alloy, which was produced initially to replace lead as a safety barrier in X-ray therapy. Later uses for Heavy Alloy were in the manufacture of mass balance weights on the control surfaces of aircraft, hubs for gyroscopes and gyrocompasses and electrical contacts.

G.E.C. Heavy Alloy contains about 90 per cent tungsten alloyed with nickel and copper. Mixing these constituents in powder form causes a liquid phase to be formed on heating (under pressure) to a moderate temperature to cause sintering. The main properties of the alloy so formed are summarised in the accompanying table.

G.E.C. Heavy Alloy

Tensile strength, tons per square inch ...	40
Yield point, tons per square inch	37
Elongation, per cent on 1in	4
Elastic modulus, lb per square inch	32×10^6
Brinell hardness No.	250–290
Specific gravity	16·3–17·0
Weight, lb per cubic inch	0·6
Coefficient of expansion	$5 \cdot 6 \times 10^{-6}$
Thermal conductivity, C.G.S. units ...	0·25
Specific resistance, ohm cm.	$1 \cdot 16 \times 10^{-5}$
Electrical conductivity, ohm^{-1} cm^{-1}	$0 \cdot 86 \times 10^5$

This material can readily be machined with ordinary tools and it can be brazed and silver soldered. A method of welding in hydrogen has been developed to allow complex shapes to be built up from simple pressings.

As a material for the arcing contacts of oil-immersed heavy-current circuit breakers Heavy Alloy has the advantage of the low vapour pressure associated with tungsten, without suffering from the difficulty inherent in the manufacture of tungsten in suitable sections.

Other electrical contact alloys include tungsten-silver and tungsten-copper compositions, the contacts being made by partially immersing a porous tungsten bar in molten copper or molten silver. The molten metal permeates the bar, filling the voids and providing a network of a metal of high electrical conductivity.

Powder metallurgy also offers advantages in the manufacture of alloys to close composition specifications such as those used as cathode filaments in valves. Nickel alloys containing controlled concentrations of aluminium or magnesium are made in this way and may include traces of metal compounds to enhance the high-temperature strength of the fine filament wire processed from the sintered alloy.

Close limits must be adhered to in the production of alloys for making glass-to-metal seals, and the limits are closely related to the composition of the alloy. Powder metallurgy ensures that the desired degree of control can be achieved and, as in the case of filament alloys, gives uniformity of properties and consistency in manufacture.

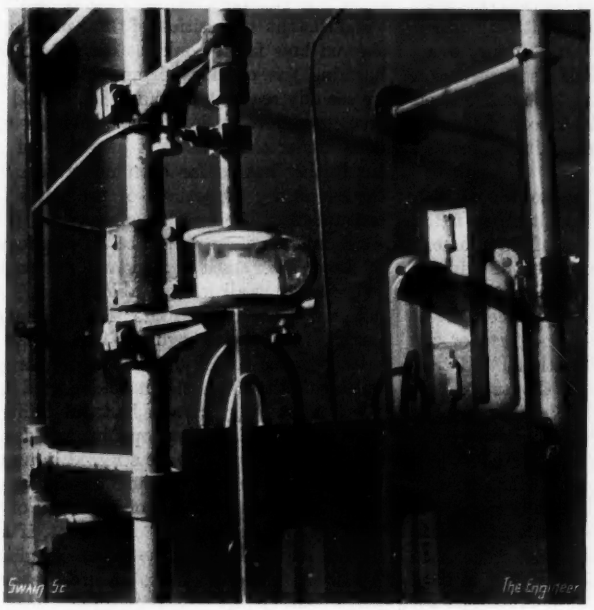
Diamond Dies for Wire-Drawing

From the processing of tungsten by powder metallurgy it is a natural step to pass on to the manufacture of diamond dies for wire-drawing. There are nine distinct operations in die-making and, as diamond is the hardest material, diamond in some form must be used for cutting. Suitable cutting and polishing powders, prepared by crushing and grading, are suspended in an oil medium between a vibrating steel needle and the diamond to be pierced. To continue this process of abrasion requires a hundred or more working hours, during which the point of the needle must be withdrawn and resharpened every thirty seconds. Although these operations are carried out automatically in a multiple-head machine, the process is inevitably lengthy.

A marked improvement was effected when the G.E.C. showed that the cutting operations could be reduced to a minimum by piercing part of the die bore with a low-voltage electric arc. The process, which we saw demonstrated, takes approximately forty minutes. The low-voltage arc is produced between the surface of the diamond (which is just submerged in a conducting fluid) and a pointed electrode touching the surface of the liquid.

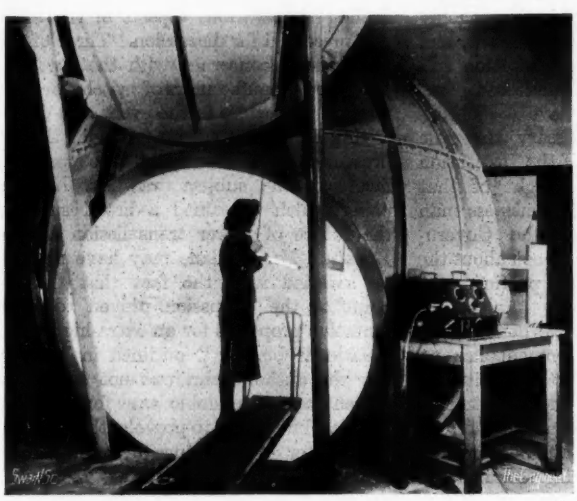
Photometry

Our final illustration shows the 12ft photometric integrating sphere which is used for making photo-electric measurements of the light output of fluorescent lamps up to 10ft long. The circular door weighs 3 cwt and is electrically operated by push buttons. An extending gangway at floor level allows the operator to enter the sphere, as shown in the illustration.



Furnace for Producing Sapphire Rod

Making Glass "Doughnut" for 30MeV Synchrotron



12 ft Integrating Photometer

Midlands Television Aerial System on Test.—The sound and vision aerial system for the Sutton Coldfield station of the B.B.C. television service, has been manufactured by Marconi's Wireless Telegraph Company, Ltd., to B.B.C. specification, and is now undergoing full tests at the company's Chelmsford works. This aerial system consists of eight dipoles which are fed by both the vision and sound transmitters through a combining unit, whereby a single aerial system can be used without mutual interference between the two transmitters. Under test the aerial system has been loaded with 35kW vision and 12kW sound power. An integral part of each of the dipoles is a system of channelling designed to carry away rain. To test this system, the aerial array has been fully loaded with sound and vision power, while a Fire Service hose has been used to play water over the whole structure for a long period, simulating a downpour far in excess of anything likely to be encountered after erection. At Sutton Coldfield this aerial system will be mounted at the top of a 715ft mast.

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NOTICE TO READERS

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COMMITTEES ON STANDARDS

THERE now exist two separate and distinct committees investigating the work of the British Standards Institution. Last week, as noted elsewhere in this issue, Mr. Wilson, President of the Board of Trade announced that there had been set up a committee "to consider the organisation and constitution of the British Standards Institution, including its finance, in the light of the increasing importance of standardisation and the extended size and volume of work likely to fall on the B.S.I. in future ; and to make recommendations." Last November, Mr. Strauss, Minister of Supply, similarly announced the formation of a committee "to investigate in consultation with the British Standards Institution, and appropriate organisations, the methods by which manufacturers and users of engineering products determine whether any reduction in the variety of products is desirable in the light of technical, commercial and other considerations ; and to report whether these methods are adequate and what, if any, further measures should be taken by industry or by the Government, to ensure that such simplifications as are determined are put into effect." These terms of reference are certainly somewhat different to those of the committee whose appointment Mr. Wilson has just announced. But, excepting in their limitation to engineering, are they so much different, since they relate to the work of a single body, that it is really necessary to have two committees, whose objects, it seems to us, must certainly overlap ? The British Standards Institution has much important work in hand. Need its work be investigated, at twice the trouble to its officials, by two committees instead of one ?

No doubt it is flattering to the British Standards Institution to find itself so much the object of the attentions of Government departments. But concentration of Governmental interest in the past has sometimes meant for the industry or body concerned the eventual extension to it, in one form or another, of Governmental or "national" control. Is there any suggestion in the setting up of the new committee that the Government is tentatively considering the possibility of taking over the Institution or its work ? We do not think, on its past record, that the Government would have much cause for complaint if such an impression were to gain ground. But Mr. Wilson's words in making the announcement lend little colour to that impression, emphasising as they do the need for industries to draft standards for themselves. "Further advances in standardisation, whether in the engineering field or elsewhere, will not be obtained without a good deal of hard work and careful technical examination and without the fullest co-operation of industry in the drafting and adoption of standards. This will mean that the B.S.I. will have more work to do and will assume an even more important place in the economy of the country than it does at present, and it will create problems of organisation and finance. The question of an increased grant from the Government will have to be considered, but it seems necessary that the constitution and functions of the Institution should be reviewed in the light of that policy." In fact, like a wise business man considering an investment, the Government seems to be learning all it can about the work of the Institution before putting more money into it.

Yet even though it may, we hope, safely be assumed that the Government has no thought in mind of bringing the Institution under the control of one of the departments of State, it does seem to us sure that it has certain changes in mind. For the Government, greatly wishing to increase productivity, is showing much concern that standardisation should be rapidly extended. Mr. Wilson gave voice to that concern when, in answer to a question, he remarked that while he was aware that standardisation had some disadvantages "far too many of the existing types are very much set in their ways, allowing an unreasonable degree of consumer choice in matters of size and specification, which no one now considers necessary"—a somewhat minatory statement. Up to date, the B.S.I. has been more concerned to standardise for quality, fitness for purpose and performance than dimensionally, though dimensional standards are by no means absent. But the Government lays particular emphasis upon that kind of standardisation which will help productivity, that is upon dimensional standardisation and the elimination of minor differences in, for instance, the specifications of materials. There is no doubt whatever that there is much scope for standardisation of that kind. Indeed, the insistent necessities of war production showed how far it could be carried without harming the quality of products. Nor do we see any reason why the B.S.I. should not give greater attention to it, providing that it is undertaken, as all the work of the Institution has so far been undertaken, by the voluntary agreement of producers and consumers of the articles concerned. What we should condemn would be the application of force, after such a standard was issued, to ensure that all makers abided by it. For not only should a dimensional standard justify itself by bringing about a fall in price relative to an unstandardised article, but a rule that it must not be departed from must necessarily have a harmful influence upon the further development of design. That was a point that we stressed in an editorial last November, when discussing the final words of the terms of reference of the committee then set up, "and what, if any, further measures should be taken by industry or by the Government to ensure that such simplifications as are determined are put into effect." It is perhaps worth stressing the point again.

HIGH-VOLTAGE TRANSMISSION IN GREAT BRITAIN

FUTURE developments in high-voltage transmission in this country received prominence at the recent British Electrical Power Convention when a group of four papers dealing with various aspects of the subject was presented for discussion. Three of these papers were concerned with the part to be played by manufacturers of switchgear, transformers and cables in the event of a demand arising for higher system voltages than the present 132kV. Unifying these particular facets of the subject was Mr. Haldane's paper which contained a broad survey of the future of power transmission in Great Britain. Mr. Haldane may have reason to be satisfied with the fact that the focal point of the discussion proved to be the tentative proposals for an extra-high-voltage "national bus-bar" outlined in his paper. For the author's aim was not so much to present an unassailable case for a national bus-bar, but rather to provoke thought about the matter or "produce more information than is at present available." It would be wrong, of course, to infer that the subject had not received previous attention ; indeed, as Mr. Pask pointed out, bulk transmission and interconnection in relation to the future has been closely studied since 1942 by the Central Electricity Board and its successors. Pending a decision as a result of these deliberations, however, little information had been published until the discussion at the Convention did something to remedy the deficiency.

Mr. Haldane's paper starts from the conservative premise that the phenomenal growth of load since the construction of the Grid is likely to continue at a rate of more

than 7 per cent per annum, with a corresponding rise in maximum demand from about 21,010MW in 1958 to about 37,630MW in 1968. An enormous increase in generating capacity is implied. To make the optimum use of the installed plant, the author postulates the need for greater interconnection and for bulk transmission, and he suggests that these functions can be best fulfilled by superimposing an extra-high-voltage national bus-bar on the existing 132-kV system. Such a super grid may be regarded as a logical development of the present system, exploiting to the full the established advantages of interconnection—economy in the overall requirements of generating plant and the operational flexibility inherent in a completely co-ordinated network. An extra-high-voltage bus-bar would also offer the possibility of saving switchgear replacement costs by splitting the system into areas to limit the rupturing capacity required. On the basis of the available information, Mr. Haldane suggests the adoption of 300kV as the maximum voltage, and outlines a tentative scheme for a national bus-bar at an estimated cost of about £22,000,000. This cost would, however, be more than offset by the consequent saving of generating plant, amounting to £35,000,000 (representing 700MW) in ten years or £88,000,000 (representing 1750MW) eventually. These estimated economies are impressive, but they are essentially the fruits of interconnection irrespective of the voltage adopted, and it might be argued that similar savings could be achieved at less cost by augmenting the existing 132-kV system. It is at this stage, when the merits of specific projects are balanced against likely alternatives, that Mr. Haldane's proposals enter the realm of controversy. In his contribution to the discussion Mr. Pask said that the detailed investigations made by the Central Electricity Board indicated that the 132-kV grid would prove adequate for its duties until about 1960. A similar study of the probable conditions in 1965–75 was still in progress, to resolve the choice between 132-kV reinforced interconnections and the 300-kV superimposed system. The choice would be difficult if it depended merely on considerations such as the disposition of new power station sites and changes in load density throughout the country. Unfortunately, the task is complicated by uncertainties about the source of power station coal, the price structure, and the cost of transport by rail. It is clear that, unless these factors can be stabilised, the economics of inter-area transmission become a matter of guesswork rather than intelligent forecasting.

In deliberations such as these the British Electricity Authority is in the unrivalled position of having access to detailed information that is not available to other bodies or individuals. It is in the public interest that the Authority, as the sole arbiter, should be concerned with the economics of high-voltage transmission, and that any alternative courses should be subjected to costs analyses. Yet this necessity itself accentuates the manufacturers' difficulties, for prototype equipment must evidently bear its portion of the development charges and no fruitful comparison, on the basis of costs alone, can be made with an established product. This dilemma, of course, is neither new nor is it insoluble. Indeed, in matters such as this, an observer may be in danger of not seeing the wood for the trees. It may be that the national bus-bar can be deferred for a few years in favour of other expedients. It may be that the predicted gains are quantitatively open to question, since they are no more than provisional estimates based perhaps on incomplete data. But the fundamental soundness of Mr. Haldane's thesis remains inviolate. The justification for the extra-high-voltage bus-bar is that it would pay for itself by virtue of the resulting economy in generating plant, and that it would offer the less obvious, but no less real, advantage of giving greater flexibility in the planning of generating plant expansion programmes and in the operation of the whole system. To reap these gains, without being able to evaluate them precisely in advance, demands the same boldness of vision that inspired the creation of the 132-kV grid. The first step has already been taken with the placing of an order by the B.E.A. for an experimental section of 275-kV line having a route length of forty miles from Staythorpe to a point near Sheffield. Such a beginning suggests the possibility that future developments may be planned in a number of distinct stages, each phase being designed to meet currently foreseeable needs without prejudicing the flexibility of the next phase. Be that as it may, the relevant decision will be eagerly awaited by the electrical industry and, in particular, by the manufacturers, who face the difficult task of striving to keep in the van of progress in high-voltage engineering, under the handicap of a home market that must inevitably provide less scope for development than many overseas countries.

Literature

Road Plan for Lancashire. By James Drake. London: Cook, Hammond and Kell, Ltd., Tothill Street, Westminster. Price 25s.

It is generally considered that road conditions in the British Isles are not suitable for the needs of modern traffic, and that a fairly widespread modernisation of roads is required. Such an amelioration of road conditions is a matter of importance, both from aspects of safety and economy. It is therefore encouraging to examine the road plan for Lancashire, prepared by Mr. James Drake, the county surveyor and bridgemaster for the Lancashire County Council.

Road conditions are particularly troublesome in Lancashire, there being a large volume of industrial traffic during the week, and a week-end flow to the coastal areas of considerable magnitude. Traffic "queues" up to eight miles in length have been encountered on the approach roads to Preston as a result of this week-end traffic, and conditions at Lancaster and other places in the county are little better, As might be expected, much trouble and inconvenience results from this congestion, and the number of road accidents is high. The objects of the road plan for Lancashire, it is stated, are "to permit all road users to move economically, at a generally acceptable speed, and under conditions of the maximum safety which can be afforded, between their various points of departure and arrival."

The plan has been evolved from a background of thorough investigation and research on the part of Mr. Drake and his staff, and a practical and somewhat conservative attitude has been adopted in formulating the various proposals. In the early part of the report, a historical résumé of the growth of the road system of Lancashire is given, and it is pointed out that the present road network is substantially the same as the system of turnpike roads in the county in 1821. By comparison, the growth of the railways since that date has been remarkable. Following the historical study, a survey of existing road facilities and conditions leads to the delineation of the new plan in the light of the conditions of adequacy quoted above.

The plan is based upon three main assumptions, governing expenditure, time and traffic flow. Thus an allowable figure for annual expenditure was obtained by assuming that, in the whole country, the same amount of road work will be carried out as before the war, (that is, about twice the pre-war monetary total, since prices are about double). Lancashire would be entitled to a proportion of this amount based upon road mileage and population. The time postulated for the completion of the proposals was thirty years, it being assumed that a longer period would have little realistic value, and a shorter period would be uneconomic. It was also assumed that the volume of traffic in the country as a whole will reach its peak in about twenty years' time, and will then be approximately double the volume in 1938.

With this basis, the new road network was deduced with the aid of statistics of traffic flow, and various design standards of safety, economy, speed, capacity and so on, which are given in the report. The effect of the new roads on traffic flow was also studied, and the predicted flows over the new system were calculated, thus ensuring that all projected roads were planned as effectively as possible. Also, the most efficient order of priority of construction was obtained from this prediction. A policy recommended with respect to maintenance, surfacing and the treatment of bridges was also considered in the report.

The proposed future road pattern is divided into three groups, the first group involving twelve express routes with a total length of 217 miles, of which about 146 miles would be completely new roads. This group includes parts of the proposed national routes, the North-South Motorway from London to the North, and the Liverpool-Hull route. The second group involves about 410 miles of roads (131 miles of new roads) designed to connect large towns to first group roads, and to form other important connecting routes. The third group routes are slightly less important than the second group, and consist of 280 miles of roads, 29 miles being completely new. All unclassified and minor roads are excluded from this classification. The completed system is, of course, not final, and is subject to any modifications that may be found necessary.

In conclusion, the report states that it is hoped that the presentation of a complete scheme will guard against the sponsoring of road schemes which appear to be desirable when seen against a limited background, but when seen against a wider background are recognised as being uneconomical. The implementation of the plan, it states, would make a major contribution towards decreasing the toll of road accidents, which, in the absence of major road improvements, would result in about 350,000 persons killed or injured within the Administrative County of Lancashire during the next thirty years, or one in every five of the population. The report is concisely prepared, containing numerous photographic illustrations and

maps and various appendices, all of which give evidence of the considerable labour which has gone into its preparation.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

TROUBLE WITH MILL ROLLERS

SIR,—Re your reader's letter, trouble with mill rollers, page 696. The trouble he speaks of is due to an air pocket being left in the roller during the process of casting. Sometimes this air pocket reveals itself by first appearing as a bump on the surface of the roller, then this, of course, breaks up.

As this is a fault due to faulty casting, the makers should, therefore, be responsible.

R. HAMILTON

Hull, June 27th.

LOCOMOTIVE PERFORMANCE

SIR,—With reference to my letter of June 18th which appeared in your issue of June 24th, under the above heading, the gradient referred to between Penrith and Shap Summit was almost exactly halved in steepness by the misplacing of one digit. This should read 1 in 125, not 251.

WM. C. BUDD

Rugby, June 27th.

[We regret the error. Fortunately, the Shap climb is so well known that we do not think it likely that any reader was seriously misled.—Ed. THE E.]

OIL SEALS

SIR,—I have noted with interest letters written by Mr. B. Cooke and Mr. F. H. Towler which appeared in your issue dated April 15th in reply to that I wrote on behalf of the Oil Seal Manufacturers' Association in your April 1st issue. The term "oil seal" is often rather loosely applied to two distinct types of sealing devices which can more properly and separately be described as "rotary shaft oil seals" and "hydraulic packings" respectively. It should be recognised that few manufacturers produce both these types of seals, rotary shaft seals having been evolved by specialist firms distinct from those making hydraulic packings. Most firms with an established reputation in the manufacture of hydraulic packings do not make shaft seals although there are admittedly one or two who cover the whole field. Members of this Association are concerned with rotary shaft seals.

I have no doubt that the firm who supplied the seal tested by Mr. Cooke is of high repute, but it is quite evident that their experience of rotary applications is very limited since no specialist in rotary sealings would even consider recommending the type employed, which can be correctly described as a "hydraulic packing." I note that this seal was typical of many tested by Mr. Cooke over a period of two years and can only repeat the statement in my previous letter that Mr. Cooke could have saved himself a great deal of time and expense had he consulted a member of this Association. Mr. Cooke also mentions having tested three different materials in an attempt to overcome the heating effect, but the root of the trouble is that the mechanical design is basically wrong, not necessarily the material.

I am now advised that more than one of our members have been consulted by Mr. Cooke and that seals submitted for similar rotary shaft duty have proved extremely satisfactory.

In reply to Mr. Towler's letter, I would point out that members of this Association have already contributed to the written discussion on the papers read by Messrs. Towler and Beacham at the Institution of Mechanical Engineers. Our members will be only too pleased to co-operate with any individual or firms requiring advice on the subject of rotary shaft oil seals.

FOR THE OIL SEAL MANUFACTURERS' ASSOCIATION,
C. R. DIBBEN
Chairman.

The Coventry Engineering Society

IN 1899, six years after its foundation, the Coventry Engineering Society elected Sir Alfred Herbert to its Presidential Chair, an office which he has occupied with distinction ever since. Last week the Society held a reception and luncheon at the works of Alfred Herbert, Ltd., to celebrate Sir Alfred's fifty years as President. In the course of his speech at the luncheon, Sir Alfred recalled the modest beginnings of the Society—which started with a membership of twelve—and spoke of its progress, the total membership now being over 1000. Sir Alfred said that if it were possible to know what had happened to all who had been members of the Society, he felt sure it would be found that many of them had attained to positions of importance and responsibility not only in Coventry, but in many other industrial centres at home and overseas. Many of the members had been, and some of them still were, apprentices, and, Sir Alfred continued, he was convinced that an apprenticeship offered the best door for an entry to the arts and mysteries of engineering. In these days of mass production, he emphasised, care must be taken not to lose sight of the value of craftsmanship. Craftsmanship used to apply to the ability of one man to produce something from start to finish, but the term must now take on a wider meaning, for the growing complexity of modern engineering practice demanded many divisions and subdivisions. Each of those divisions still required the spirit of true craftsmanship for its successful results, and that spirit must be combined with a full sense of responsibility and no small knowledge of human nature. Sir Alfred then announced that his company had arranged for a special lecture to be given to the Society each year for the next five years, the lecturers to be leading figures in history, philosophy, literature, art and economics. As a memento of the occasion, Mr. H. H. Harley, a Vice-President of the Society, presented Sir Alfred with a bound volume, prepared by the Coventry Art School, containing the names of the members of the Society. In addition, he announced that a plaque commemorating Sir Alfred's record as President would be erected in the Coventry Technical College, and that a bird bath was to be placed in Lady Herbert's garden. It is of interest also to recall in connection with the celebration that the Society's first President, Mr. H. H. Moore, was originally a draughtsman at Alfred Herbert, Ltd. He now lives in retirement at Loughborough.

The Anglo-American Council on Productivity

AN announcement made on Wednesday by the United Kingdom section of the Anglo-American Council on Productivity states that arrangements have been made to send an expert panel to the U.S.A. to study the application of simplified practice in American industries and the applicability of similar techniques to British industries. This panel will follow the course outlined by the Council at its second session in April, in which, it will be recalled, emphasis was put on standardisation, simplification and specialisation. The Council says that it attaches particular importance to the immediate benefits to be derived from the intermediate process towards full standardisation, which is known as simplified practice, and which aims at limiting the ranges of sizes or grades of products in order to cut costs and increase output by enabling longer runs to be made in production processes. The panel is to hold discussions with U.S. Government agencies, national organisations, trade associations and firms, and its aim will be to form an appreciation of what has been achieved in this particular field in the U.S.A., the methods employed, and the effect on productivity and cost. The panel will also be required to assess how far such experience could be adapted to British conditions and the extent to which it would benefit British industry. The membership of the panel is as follows:—Major-General J. S. Crawford, director of Guy Motors, Ltd., and Vice-President of the Society of Motor Manufacturers and Traders; Mr. C. A. Martin, British Thomson-Houston Company, Ltd.; Mr. Robert Neill, Lucas Electrical Company, Ltd.; Mr. G. Weston, Deputy Director of the British Standards Institution; Mr. Bertram White, Technical Director of the Federation of British Industries, and Mr. C. J. A. Whitehouse, Secretary to the Ministry of Supply Committee on Standardisation. Another announcement made by the Council this week is that a productivity team from the pressed metal industry left yesterday for America and will be away for about six weeks. This team is led by Mr. James Milner Phillips, managing director of Motor Panels (Coventry), Ltd., and hopes during its tour to inspect about fifteen plants in the U.S.A.

Hungry Horse Dam

ACCORDING to a report in *Engineering News-Record*, the Hungry Horse dam in North-Western Montana will contain the lowest cement content ever used by the United States Bureau of Reclamation in a mass concrete dam. A new technique, evolved at the concrete laboratory of the Bureau of Reclamation, will involve the first major use of pozzolan, a soot-like fly ash, in the construction of the dam. About 30 per cent or 40 per cent of the cement will be replaced by this new material, resulting in a total saving of about 4¼ million dollars. The pozzolan to be used is a waste product of combustion obtained from the flues of coal-burning industrial furnaces in the Chicago area. It is claimed that a better concrete will be obtained from the use of this new material, increased workability, decreased permeability and less segregation and bleeding being obtained by its use. In addition, the heat of hydration will be reduced, and hence there will be smaller volume changes and less artificial cooling required. The first concrete of the Hungry Horse dam will be placed in the autumn. The completed structure will be 520ft high and will be the world's fourth largest dam.

BOOKS RECEIVED

Principles and Practice of Radar. By H. E. Penrose. London: George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Price 42s.

Five-Figure Tables of Mathematical Functions. Second edition. By John Borthwick Dale. London: Edward Arnold and Co., 41 and 43, Maddox Street, London, W.1. Price 6s.

Electricity in the Small Workshop. By Ian Bradley and Norman Hallows. London: Percival Marshall and Co., Ltd., 23, Great Queen Street, London, W.C.2. Price 3s.

Metallurgical Abstracts (General and Non-Ferrous). Volume 14, 1947. S. G. Guillan and W. G. Askew. London: Institute of Metals, 4, Grosvenor Gardens, London, S.W.1. Price 60s.

The Properties of Soft Solders and Soldered Joints. By J. McKeown. London: British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1. Price 17s. 6d.

Finance of Oversea Trade. Second edition. By W. W. Syrett. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 15s.

Engineering Materials and Processes. By L. H. Hancock. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 15s.

British Electrical Power Convention

No. III—(*Continued from page 684, June 24th*)

IN this article we continue our report of the joint discussion of the four papers on high-voltage transmission in Great Britain, by Messrs. T. G. N. Haldane, B. H. Leeson, H. S. Holbrook and T. R. Scott.

Mr. D. P. Sayers (B.E.A. Central Authority) said that for the purpose of the investigation which the B.E.A. now had in hand, it had been assumed that a national demand of 30,000MW would be reached between 1965 and 1975. The precise date was not critical in a study of this kind, but Mr. Haldane's figure of 37,630MW in 1968 appeared rather high, as did his assumed load factor of 55 per cent. At the same time, he hoped Mr. Haldane was right, as the value of the improved load factor in reducing supply costs could not be over-emphasised. In this matter, however, the Central Authority was in the hands of the Area Boards and it was up to them to find ways and means of filling up the valleys in the load curve.

The main problem in Mr. Haldane's paper revolved around two fundamental issues. First, there was the transfer of energy in the form of coal, versus the transmission of electrical energy generated near the pits, and secondly, there was the question of the voltage to be used for future main transmission systems.

With regard to the first, a number of preliminary investigations had been carried out and figures arrived at for 132kV and 275kV. In the former case, it seemed that at 70 per cent load factor, electrical transmission was cheaper for distances greater than 22 miles. In the case of 275kV, for the same load factor, transmission was cheaper for distances greater than 34 miles. Against sea transport of coal, it was more difficult to compete. The Authority owned a collier fleet and was purchasing more vessels to serve coastal and estuary stations. The electrical engineering industry should regard this as a challenge, as development of seaborne coal facilities would profoundly affect the future prospects of high voltage transmission in this country.

With regard to the need for Area interconnection, Mr. Haldane referred to plant outage due to breakdown of 8 to 10 per cent. Actually the average outage from all causes last January was 12·1 per cent, made up as follows: breakdown, 5·9; overhaul, 3·1; unsuitable fuel, 1·3; and other causes 1·9. Whether these figures could be further reduced remained to be seen, but if the author's figure of 6 per cent was intended to be overall, then it seemed lower than could be expected.

On the question of voltage, he said he wished Mr. Haldane had been more explicit as to the reasons for a higher figure than 132kV. It was quite true that there was need for substantial reinforcement of the existing inter-Area tie lines; it was true also that there might be economic justification for heavy capacity lines for bulk electrical transmission, but whatever happened there must be a considerable development of the 132-kV system within each Area. Therefore, the question was, could or could not all future requirements be met by planned extension of the 132-kV system? After considering some of the pros and cons of 275kV compared with 132kV, he said that to secure an effective increase in route capacity, double circuit 275-kV construction must be used, and the larger towers might create new problems in regard to amenities and obstruction to aircraft. On the technical side, he said that the service performance of 275-kV equipment under British climatic conditions has yet to be proved, but it was in the economic sphere that the relative advantages of 132kV and 275kV were most keenly at issue. Admittedly, the basis of comparison was not simple, but according to present information the cost ratio of 275-kV to 132-kV equipment was likely to be of the following order on an MVA basis: overhead lines, 0·5; cables, 1·0; transformers, 2·0; and switchgear, 1·5. Except for overhead lines, these prospective costs gave no economic inducement to the adoption of the higher voltage. It was difficult for the user to understand the justification for higher prices for 275-kV equipment, as it would be expected that the larger units would show a reduction in the cost per MVA. Manufacturers said that research and development charges were responsible and he had endeavoured to make some assessment of this from a comparison of weights and prices of cables. According to the preliminary information available, a 275-kV cable would have a weight ratio of 3 : 1, and a price ratio of 5 : 1 as compared with an 11-kV cable with the same size of core. If the cost of manufacture was roughly proportional to the weight of material, this meant that some 70 per cent of the prospective price to be paid for 275-kV cable was not accounted for by materials and making. Similarly, the cost per pound weight of 275-kV transformers and switchgear was substantially more than for lower voltage equipment. If these excess costs were due to development charges, surely there was the clearest possible case for British manufacturers to get together and co-ordinate or rationalise their developments so as to avoid half a dozen firms each pursuing independently much the same protracted and expensive research, because it was the British consumer who had to pay in the end.

Finally, he said he was satisfied that with the centralisation of planning of the national power resources made possible by the Act of 1947, very substantial future economies could be effected by the development of our main transmission systems on a bold and comprehensive scale.

Mr. G. R. Peterson (B.E.A., Liaison Office Overseas, Geneva) commenting on the reference in Mr. Haldane's paper to the use of high voltages overseas, said that these high voltages could be for two distinct purposes, viz., for transmission, and also for what had been described as the national bus-bar. Up to the present, the use of high voltages overseas had been used for the first of these two purposes, and there was some danger of misunderstanding arising out of Table II in the paper. Many of the high voltages mentioned there were for bulk transmission and were not necessarily an indication of the most suitable voltage for a national bus-bar. It was now some 30 years since 220-kV and higher voltages had been introduced abroad, but the conditions in this country were very different in that we had not the need to transmit over such long distances. The possibility of establishing a high voltage national bus-bar was being discussed at the present time in many countries, and as regards the possibility of a European high voltage grid, he was able to say that this was the subject of a detailed study as part of the European recovery plan. There was an organisation known as the Power Committee of the Economic Campaign for Europe which was doing work along these lines. There was also a Power Committee of the Organisation for European Economic Co-operation set up under the Marshall Plan, and the Americans concerned with the Marshall Plan had been taken with the idea that a European high voltage grid would lead to economies in the utilisation of European power resources. They were so convinced of this, that they had recently sponsored a visit of some 24 European engineers to the United States to inspect water power development there. The difficulty so far as this country was concerned seemed to be to prove before it was constructed that a national bus-bar would be an economic proposition. Nevertheless, it was the fact that the success of the national grid in this country had for many years drawn the favourable comment of the whole world. That success was not solely due to the favourable conditions in this country. It was largely due to the foresight and courage of the administrators and engineers 23 years ago, and the time might be ripe now for a further step forward; it might well be that we should then give another demonstration to the world of British skill and initiative.

Mr. F. J. Lane (B.E.A., Central Authority) expressed the view that not only would a national bus-bar offer no solution of the difficult question of switchgear breaking capacity, but it would rather make the conditions worse. On the present 132-kV system the short-circuit level had risen to such values that we no longer countenanced the purchase of new circuit breakers of 1500MVA rating, and at the latest generating stations where plant capacity might be expected to expand beyond 300MW to as much as 700MW, a rating of 3500MVA might be barely adequate. Although circuit breakers could be designed for higher ratings it was noteworthy that even at 3500MVA there was some pressure from manufacturers that in specifying rates of rise of restriking voltage, due regard should be paid to the characteristics of the system at the location where the breakers were to be applied. The rating of 3500MVA inferred the interruption of a current of 15,300A, and it seemed desirable that this should be regarded as a limit for 132kV. If such a limit was accepted as desirable, it was clear that steps must be taken to restrict the maximum short-circuit duty at points of major concentration of plant. The normal development of the 132-kV system and the design limitation of 132-kV circuit breakers made it essential to design the supply system so as to restrict short-circuit duty, and so long as the interconnection continued at 132-kV level the natural restriction inherent in the separation of the points of interconnection was of very material assistance. The 275-kV scheme, however, envisaged the provision of circuits of large capacity between major generation centres and between major generation centres and load centres. This, in turn, involved the collection of 132-kV circuits at suitable focal points, both for concentration of generating plant and for distribution of transmitted load, and it employed interconnecting circuits which, if not of much smaller reactance than the equivalent 132-kV connection, were more direct connections between points of heavy short-circuit duty than the separated and diverse interconnections which would be

employed in a 132-kV system. The concentration of 132-kV connections on selected focal points would increase the difficulty of short-circuit limitation at that voltage level and, further, the introduction of step-up transformers for the higher voltage system would increase the rate of rise of restriking voltage on the circuit breakers themselves as compared with the ameliorating effect of additional 132-kV line connections with their associated capacity. It thus appeared that the problem of short-circuit rating would not be eased by the employment of an additional level of high-voltage transmission.

It was quite clear that the amount of 275-kV equipment required during the next ten or fifteen years, while appreciable, would not provide a wide enough field for experimentation. Furthermore, the Authority was responsible for the security and economy of supply, and it would be highly undesirable that the number of types of equipment should be multiplied to the detriment of maintenance, repairs and operating technique.

Finally, he said that the manufacturers' papers were largely collections of evidence that satisfactory designs of equipment were available for operation up to 300kV. If a higher voltage than 132kV was necessary, many would feel that the choice of 275kV was too hesitant a step to be of long-term value either to the supply industry or to the manufacturers. Yet it seemed to be all that was really possible immediately, having regard to the design, manufacture and commercial considerations involved. But the whole picture might be changed if manufacturers and the supply engineers could, in free technical association and as a primary objective, attack the problems associated with transmission at 380kV. Development on this basis would enlarge the field of supply utilisation and would provide experience which would be of inestimable benefit in the competitive markets of the world.

Mr. F. C. Winfield (representing the Institution of Electrical Engineers) thought there was a danger that in regard to this problem of increasing the voltage of transmission above 132kV we might become blinded by science. There was the virtue about Mr. Haldane's proposals that he was following the well-tried method of electric supply up to now throughout the world, whereas what the other proposals were he was not quite clear. If these other proposals were simply to substitute 132-kV connections, that was a matter of simple economic evaluation for which the answer could be determined easily. If, however, the other proposals meant interconnecting the spokes of the wheel, so to speak, that really meant expanding the 132-kV system of interconnections all over the place and he would like to know how it was proposed to control the interchange of power between the Areas. That was the weakness of interconnected systems. Mr. Pask had mentioned that the present system had an interchange capacity of 320MW. That figure rather astounded him and it would be interesting to know if the control engineer would back that. Could he send 320MW from one area to another when he wanted to, on the average. Personally, he would be surprised to find that the answer was "Yes." Mr. Pask seemed to suggest that with the present system all that was needed was to get the connection between Sheffield and Staythorpe into operation, but personally he regarded connection between England and Scotland and also between the North-East and the Midlands at the present time as too weak. The position in England was very different from that on the Continent. Owing to the density of industry and population a 132-kV urban network was simply a distribution network and nothing more, and his general feeling was that if they went on with 132kV their sons and grandsons would curse them.

Dr. W. B. Whitney (E.R.A.) spoke of the part the British Electrical and Allied Research Association was playing in regard to problems of higher voltage, and said that it often had to think twenty years ahead and not ten years as had been mentioned. It was encouraging to see from these papers the practical outcome of much of this long-range thinking. Many of the problems mentioned in Colonel Leeson's paper were now the subject of research. From the point of view of the fundamentals of arc rupture he could say—as one closely connected with research and experimental development of modern types of oil and of air-blast circuit breakers for more than twenty years—that there was no reason why a.c. circuit breakers for 300kV, or 400kV, or even 500kV should not give as good and reliable service as the many excellent breakers for lower voltage now in use. However, he was not satisfied that 66kV per break, as mentioned by Colonel Leeson, was the upper limit for air-blast breakers. It should be possible by suitable design of nozzle and gap to handle higher voltages per break, which would be an advantage as it would simplify certain problems of air and voltage distribution.

Mr. C. W. Marshall (B.E.A., Central Authority) said that as regards lightning, the excellent performance of the 132-kV transformers during recent years should give confidence that higher voltage transformers would be, to all intents and purposes, immune from lightning hazard. On the other hand, the climate hazard was a much more insidious thing, and in certain industrial areas conditions had occasionally been encountered which demanded attention. That was why he recommended caution in going beyond 300kV. As regards discriminating protective gear, he said that with very high power circuits the present-day standard of 95 per cent was not good enough. It was possible to obtain 100 per cent on any system, and when the money was forthcoming it should be possible to provide apparatus which would clear the few faults that should come along with very high pressures. Although he had referred to the high standard of performance of transformers, it must be realised that this had been purchased largely by experience on the grid system. For instance, in 1927 there was practically no impulse testing, but to-day it was standard practice, and nobody could hope to build a satisfactory transformer if they did not impulse test. Referring to the export trade, he said he had had experience of foreign practice and knew that supply engineers abroad were envious of the extraordinary reliability of large British transformers. There was, however, a difficulty about the question of price which often did not enable us to compete. Reliability, however, was so important that it would be interesting to have records of the reliability of foreign-made transformers and the collection of information of that nature would be most valuable. Although high-voltage d.c. had been mentioned, he did not think it was yet possible to contemplate large-scale application.

Mr. R. M. Charley (English Electric Company, Ltd.) said he had had the privilege of being able to tell the world, during visits and lectures in many countries, of the achievements of British transformer makers, and he ventured to say that we had been negligent in this country in not advertising ourselves sufficiently in that direction. He gave a few details of many large machines sent overseas from as far back as 1910 and said that in that way British makers had accumulated a large amount of valuable experience of high-voltage operation before it was needed in this country. The result was that British makers were ready to supply 132-kV transformers immediately they were required here. In 1942 British makers had started producing transformers for 220-kV and higher voltages. Now, as Mr. Pask had mentioned, transformers in the 300-kV class had been ordered for this country and these transformers were comparatively simple for British makers to build. They were 120-MVA, three-phase units, auto connected for a voltage ratio of 275/132kV. British makers were also producing very much more complicated units. These were large units and very expensive, the price being £150,000, but he asked them not to divide the £150,000 by the 90MVA mentioned in Mr. Holbrook's paper in order to get at the price per MVA, because that would be meaningless. It was necessary to have complete information of all the factors involved. It was impossible to judge from the price per MVA whether the price was right or not.

Convention Dinner

On Thursday evening, the Prime Minister, who was the principal guest at the convention dinner, proposed the toast of "The Electrical Power Industry" and referred in general terms to its difficult task of meeting home demands while supplying export needs. Lord Citrine, in his response, made a plea for an increase in the permissible power plant expansion programme, without which there was no hope of meeting the peak demand for some years to come. The toast of "Our Guests" was ably proposed by Sir John C. Dalton; the Mayor of Torquay, Alderman Frank J. March, responded.

At the final session of the convention on Friday, June 17th, Mr. P. G. Wallis presented for discussion a paper on "The Electrical Contractor's Place in Industry and His Service to the Public."

Exhibitions

The exhibition organised by the Electrical Development Association to run concurrently with the convention, was opened by Lord Citrine on Monday 13th. There were eighty-five exhibitors, broadly representative of the electrical industry, with particular reference to the products of manufacturers catering for the needs of the electricity supply industry and the domestic consumer. In addition to the main exhibition, which was held in a marquee, there was an exhibit by four member firms of the Electrical Vehicle Association.

At the same time, the Cable Makers' Association staged a demonstration of scientific apparatus used in cable research and development work. This exhibition, which was held in the South Devon Technical College, Torquay, provided an interesting background to the convention paper presented by Mr. T. R. Scott. One group of demonstrations, concerned with the testing and examination of materials used in cable-making, included equipment for applying fatigue tests to lead sheathing, and apparatus for taking power factor measurements on paper tapes removed from the insulation of a cable. In addition, the use of spectrographic analysis for examining metal alloys was demonstrated, using the micro-photometer. Another useful method of non-destructive testing which was demonstrated was the use of X-ray diffraction to provide information on the atomic arrangement,

character and size of individual crystals in solid materials.

Equipment designed for high-tension testing included a 500-kV impulse generator and its associated continuously-evacuated cathode ray oscillograph. Other demonstrations in the high-tension field included a new design of surge counter in the form of an electronic device for automatically counting surges of various amplitudes on transmission systems; an ionisation detector bridge for studying the behaviour of super-tension cables under stress conditions; and the suppression of ionisation by gas pressure.

Crossing the Atlantic

(Contributed)

WRITING about a century ago, Emerson described his voyage from Boston to Liverpool during October, 1847, when he was a passenger in the sailing packet-ship "Washington Irving" of 750 tons register, length between perpendiculars 155 ft. Commenting on his journey, the philosopher remarked that "the worst impediment I have found at sea is the want of a light in the cabin." He further affirms that "whatever dangers we are running into, we are certainly running out of the risks of hundreds of miles every day, which have their own chances of squall, collision, sea-stroke, piracy, cold and thunder. Hour for hour, the risk on a steamboat is greater; but the speed is safety, or twelve days of danger, instead of twenty-four." Eighteen centuries before Emerson's time, Horace remarked how the heart of the first man to commit a frail bark to the rough seas must have been mailed in oak and triple brass:

"Illi robur et aes triplex circa pectus erat, qui fragilem truci commisit pelago ratem,"

Indeed, the old navigators—such as Phaeas, who navigated Theseus' ship—would have deemed Emerson unduly apprehensive, though Clidemus tells us that about B.C. 1200 the Greek maritime authorities published a regulation which prohibited any person to sail in any vessel or bottom which carried more than five individuals "except only Jason who was captain of that great ship 'Argus'." Such particulars, joined with the above-quoted observations of Emerson, show how little technical progress was made in ocean navigation until about the middle of the nineteenth century.

In 1901, the vessel in which the present writer crossed the Western Ocean was the "Minnehaha," of the Atlantic Transport Co., 13,280 tons gross. That ship had then been in service for about one year and represented the last word so far as relates to the propelling machinery of passenger vessels engaged in the North Atlantic trade. The twin-screw engines were quadruple expansion, 30in, 43in, 63in and 89in by 60in stroke. There were eight Scotch boilers, pressure 214 lb per square inch, and my recollection is that we took ten days to get from Tilbury to New York. The "Minnehaha" was certainly a very comfortable ship and I spent much of my time with the Chief Engineer, Mr. Bell, who was known—someone told me—as "tin-hat" Bell, from his practice of enveloping boiler stop valves and certain other heat-radiating fittings with sheet steel covers providing air insulation. He was a very good marine engineer and I well remember him telling me that on an occasion when he was boiler-crawling, steam had been inadvertently turned into the boiler with the result that much of his skin was flayed off by the scalding; it seemed miraculous that he had ever survived. Mr. Bell reminded me strongly of Kipling's McAndrew, who recorded how, on one occasion,

> "Three feet were on the stokehold floor—
> Just slappin to an' fro—
> An' cast me on a furnace door.
> I have the marks to show."

I now find myself, after an interval of about 45 years, crossing the Atlantic again in another ship built and engined by Harland and Wolff, but there is no stokehold. Here, in the "Britannic," we have oil engines, two sets of double-acting four-cycle diesel engines each with ten cylinders. These, with the engines of the "Georgic," must be the largest four-cycle cylinders ever put into a ship, the bore being 840mm, stroke 1600mm. The designed collective output at 102 r.p.m. is 18,500 s.h.p., giving 925 s.h.p. per cylinder. They were the last air-blast engines built at Belfast, the blast air being provided by independently driven air compressors. The "Britannic" is almost exactly twice the size of the "Minnehaha" of nearly half-a-century ago and everything seems different. I wonder what Mr. McAndrew would have had to say about these internal combustion engines. He looked for "the loco-boiler next an' thirty mile an hour." That was in 1893, seven years before the "Britannic," when it must certainly have seemed fantastic to suppose that the Atlantic would be crossed in ships propelled by machinery requiring no boilers.

Emerson found the sea life "an acquired taste. . . . The confinement, cold, motion, noise and odour are not to be dispensed with." We may wonder what he would say now were he to travel in air-conditioned fluorescent-illuminated luxury, with neither sails, motion, smells nor other occasion for sea-sickness. Here, the promenade deck is more than twice the entire length of the "Washington Irving." Even if the diesel engines, radar, radio, cinema, automatic fire extinguishers, water-tight bulkhead doors, electrically-operated capstans and synchronised clocks might prove perplexing to him, the admirably stocked library would so far transcend what he calls "the usual cabin library" as to make him suppose that the range of public reading had kept pace with the revolution in scientific navigation. We may imagine with what pleasure the Sage of Concord would have enjoyed his hot sea-water bath, stretched himself in a cushioned deck-chair and confirmed his former impression that among the passengers on Trans-Atlantic ships "there was some variety of talent and profession," and that here "the busiest talk with leisure and convenience . . . . and sometimes a memorable fact turns up, which you have long had a vacant niche for, and seize with the joy of a collector."

There is without doubt an inspiration which comes to one when looking from the ship on to the perimeter of salt water, particularly when the south-westerly breeze is etching the whole expanse with silvery wave-crests. This, together with the refreshing Atlantic air, is something not to be experienced in a mechanised rocket passing above the clouds and spanning the ocean in a few hours. Here, in this extremely strong and beautiful ship, we are comforted during foggy weather—even when the siren is sounding the statutory blasts—by the reflection that with radar, our security is more or less unaffected by the surrounding gloom, where objects invisible to the eye of the navigator can be scanned by him on an illuminated screen. Indeed, to pass through a fog at sea knowing that the position of any solid objects is seen by the navigator on the bridge is an experience not without its thrill.

If the propelling and navigational equipment of the modern ship differs in a revolutionary degree from what was found in the ships of half-a-century ago, the difference is equally significant when one examines the smaller details as, for example, the materials used in clothing and decorating the interior spaces. Brass is still to be found, timber is still to be found, but stainless steel, plastics, chromium plating, &c., are everywhere, and the improvement in appearance must be accompanied by an impressive reduction in the labour of cleaning. Plastic cabin walls assembled in units and secured by rustless attachments produce a delightful interior, and gone are the brass railings hitherto ubiquitous. It must make as big a difference to the joiner's shop as it does to the persons who have to keep the walls and fittings clean. Very striking, too, is the change in the deck conditions where electrical power is used for the silent operation of winches, &c. With totally-enclosed motors and control gear the deck machinery of the modern passenger ship is not attended by the disfigurement due to steam and exhaust pipes, innumerable valves, steam and water leakage, grease and dirt. Certainly one of the conspicuous changes which has taken place during the last fifty years is this great amelioration in the deck conditions as affected by the type of machinery there installed.

The only things that do not change are the weather, the ocean and the channels. The pilot has just come on board and he will take us up that Ambrose channel which marks the bed of the Hudson river at a time when the coast line extended to Sandy Hook. Land is now in full view on the New Jersey and Long Island sides and we are joining the stream of ships converging on New York Harbour. Here it is that the traveller, returning after many years, is concious of a vast change in the skyline. Back of the old group of down-town skyscrapers stand those gigantic buildings which, the highest man-built structures in the world, make the buildings of 50 years ago look like the foot-hills of the Alps and cause the Statue of Liberty to look like a mere statuette.

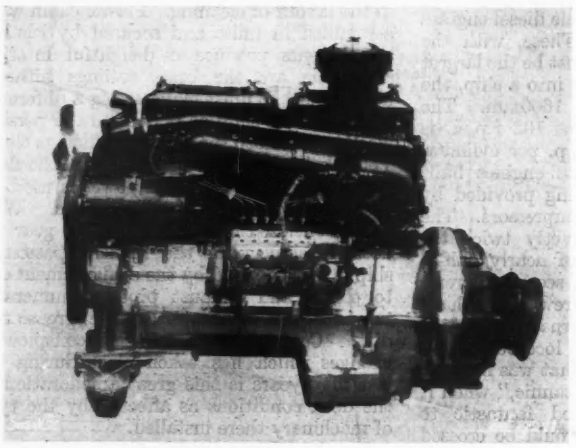
From Rock Light, Liverpool, to Castle Gardens, New York, we have taken about 178 hours and at 93 r.p.m. the diesel engines must have made about 1,000,000 revolutions each. As the "Britannic" moves up the Hudson river the old scene appears again, the everlasting freight car barges—now moved, for the most part, by diesel-engined tugs—the piers and very occasionally an ancient tug with non-condensing steam engines. A notable new feature is the mighty George Washington bridge, surely one of the most magnificent works of the kind ever executed. Another new feature is the amazing celerity with which, on a conveyor, the baggage goes off.

Crossing the Atlantic has become a sheer pleasure and "The unplumb'd, salt, estranging sea" has lost its terrors.

EBONITE BOBBINS.—Increasing use is being made in the textile industry of moulded ebonite bobbins, following trials over the last two years at various Bolton spinning mills. The bobbins are made as one-piece mouldings, to very fine limits, of a tough homogeneous material. It is claimed that they have great shock resistance, do not absorb oil or water, do not crack or splinter, eliminate mill-marks on yarn, and have no metal parts to chip off to cause a fire hazard. They are being produced by United Ebonite and Lorival, Ltd.

A.E.C. 150-B.H.P. Oil Engine

WE have received particulars of a new 11·3 litre, 150 b.h.p. direct injection oil engine, which is now being made by the Associated Equipment Company, Ltd., of Southall, Middlesex. This engine has been developed to meet the growing demand from overseas for a larger unit than the 9·6 litre six-cylinder engine which is the standard unit for the company's Mark III range of passenger and goods chassis. This 9·6 litre engine fully meets the needs of most operators in this country, but a larger engine has for some time been required by overseas customers, not only for road vehicles, but for earth moving plant and other applications. The new engine incorporates many features common to the 9·6 litre model, and is available with the fuel injection pump, dynamo and other auxiliary equipment mounted on either the right or left-hand side.



DIRECT INJECTION 150-B.H.P. OIL ENGINE

The new six-cylinder engine, a photograph and performance curves of which we reproduce, has a bore of 130mm, a stroke of 142mm, and provides 150 b.h.p. at 1800 r.p.m., and 505lb ft torque at 1100 r.p.m. The dry weight of the engine, including all auxiliaries, is about 1700lb.

Its cylinder block is a one-piece casting bolted to the upper face of the crankcase by the main bearing bolts, which are extended upwards for this purpose. The crankcase, however, is divided at the crankshaft centre line, and is provided with strong transverse webs between the adjacent cylinders and stiffened longitudinally by wide joint flanges to give a light yet rigid structure. Renewable dry liners of centrifugally cast iron are fitted to the cylinder block. The cylinder heads are formed in two units, each covering three cylinders.

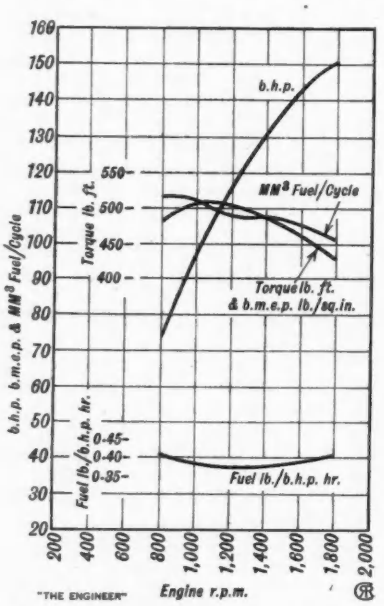
Overhead poppet valves are operated by push rods from the camshaft, which is situated in a tunnel in the crankcase. Flat-faced piston-type cam followers, made in chilled cast iron, transmit the cam motion to the valves, the chilled face giving a minimum of wear for both the tappet and the cam. Adjustment of the valves can be easily made after removing the single light alloy cover fitted over the cylinder heads. A large diameter oil bath air cleaner is fitted as standard.

A simple timing gear train of wide-toothed helical gears is situated at the front of the engine, and incorporates a split spring-loaded idler wheel to take up backlash in the timing gears. A vernier adjustment is fitted to permit accurate setting of the camshaft gear wheel.

The lubrication system follows the usual A.E.C. practice of combined pressure and splash. A gear-type oil pump mounted beneath No. 1 main bearing cap is driven from the crankshaft and draws oil through a large detachable gauze strainer in the rear well of the sump. The oil is delivered under pressure past a relief valve and through a felt-type external oil filter to the main and big-end bearings, and to the bearings of the oil pump idler wheel and the idler wheel in the timing gear train. A special metering device incorporated in the oil pump delivers a small quantity of oil under low pressure to the camshaft No. 1 bearing and to the overhead valve gear, surplus oil being returned to the sump, lubricating the cam followers and the camshaft bearings on the way. The pistons, gudgeon pins and timing gear teeth are lubricated by splash.

A centrifugal water pump, mounted on the engine, is fitted with a self-adjusting carbon gland and is driven, together with a six-bladed fan and dynamo, by twin vee belts from the crankshaft. Engine cooling water is fed into the rear of the rear cylinder head, from which a limited quantity passes into the front cylinder head through a communicating pipe, the remainder passing into and through the cylinder block to the front cylinder head through communicating holes.

The fuel-injection pump is carried on a platform mounted on the side of the engine, a flywheel forming part of the driving coupling. This flywheel is designed to smooth out the impulses due to the fuel-injection pressure, and relieve the pump drive and governor from stresses so caused.



PERFORMANCE CURVES

Heat-treated aluminium alloy pistons fitted to the engine are "barrel" shaped to provide a true fit and minimum clearance on the thrust faces at working temperatures; the compression ratio is 16 to 1. A toroidal combustion chamber is formed within each piston crown and injection into it is direct from a four-hole nozzle. Air swirl is promoted during the induction stroke by using masked inlet valves.

The dynamically balanced drop-forged alloy steel crankshaft is carried in seven main bearings of large dimensions, lined with white metal for the top halves, and lead bronze for the bottom halves. Lead bronze is also used for lining the connecting rod big-end bearings. The connecting rods are "H" section alloy steel stampings with "solid" type small ends.

Starting is effected by electric motor, and provision is made for driving either an exhauster or an air compressor from the engine.

Accidents on Railways, 1948

THE Annual Report for 1948 of the Chief Inspecting Officer of Railways shows that train accidents during the year resulted in the deaths of thirty-nine passengers. Of these fatalities twenty-four occurred at Winsford, seven at Wath, five at Stockport, and one each at Woolwich, King's Cross and Alloway. This compares with ninety-three deaths in 1947 and represents one fatality for every 42,000,000 passenger journeys.

Passenger travel on British Railways, as represented by journeys at 1,002,000,000, was about 7½ per cent less than in 1947. Total passenger and freight train mileage at 364,000,000 was 14,000,000 more than in 1947 but about 53,000,000 less than in 1938. Freight tonnage at 275,000,000 remained at a high level, some 7 per cent above 1947.

In movement accidents, other than train accidents, forty-eight passengers were killed, as compared with fifty-five in 1947. Of this total, thirty-eight lost their lives through falls from platforms and trains and when entering or alighting from trains. The principal causes were misadventure and carelessness or misconduct on the part of passengers themselves. Fatalities in all movement on rail, excluding trespassers and suicides, totalled 340, which was sixty-nine less than in 1947, the reduction being mainly due to fewer deaths of passengers in train accidents and of railway servants in movement accidents.

Deaths among railway servants in all movement on rail numbered 191 and injuries 2678, neither figure greatly exceeding the averages for the periods 1935–39 and 1930–34. There were 125 deaths while working, walking, or standing on the permanent way on duty.

In all, 1293 train accidents were reported in 1948, compared with the average of 745 for 1935–39, and twenty-seven of them had fatal results, the most for many years. The causes are analysed as follows: failure of the human element 639, defective apparatus 188, and other causes (such as running into snow or animals on the line, and the misconduct of passengers and other persons) 466. The figures show a continued increase since 1946 in accidents due to human failure in various ways.

The Chief Inspecting Officer considers that fifty-four deaths out of seventy-four in train accidents might have been avoided by greater care on the part of the railway staff immediately concerned. The other twenty fatalities occurred at level crossings, where users themselves were primarily responsible. Various specific accidents caused by failure of the human element are referred to in the report, and the collision at Winsford is quoted as a rare example of inexcusable breakdown in operation, due to non-observance of block working discipline on the part of a signalman. The liability to human failure, however, has been recognised by the decision of the Railway Executive to standardise an additional block control. This is only one feature of a programme of preventive measures to be spread over several years.

The report refers to investigations carried out during the year with automatic train control equipment, and states that the Railway Executive is now arranging for an extended trial between New Barnet and Huntingdon. For this trial sixty-five engines will be fitted with equipment of non-contact type, incorporating the former G.W.R. bell, siren and brake-actuating cab apparatus, operated by a magnetic inductive receiver passing over magnets on the track.

The Chief Inspecting Officer deals with other aspects of operation which have a bearing on

the incidence of accident. He records marked improvement in locomotive reliability as compared with 1947, the number of engines out of service for repair having fallen by nearly 600. As a result, also, of expediting repairs and scrapping, the wagon position continues to improve, the number of vehicles under and awaiting repairs (just over 100,000 at the time of reporting) being less than half what it was eighteen months before.

The biggest problem, however, is the shortage of coaching stock. In 1948 heavy loading of main line and some suburban services continued and passengers still suffered much inconvenience and lack of reasonable comfort. The improved repair position increased the number of vehicles available for traffic by over 2200; but more than 20 per cent of the stock of 55,500 was at least thirty-five years old and coaches which would normally have been condemned had to be kept in service by heavy and uneconomic repairs. Renewals totalled only 1334 vehicles during 1948, but 1540 had to be withdrawn, including sixty-seven damaged beyond repair in accidents.

A noteworthy feature is that the new stock is more strongly constructed to resist shock, and, as it goes into service, this tends to reduce the incidence of casualty in the event of accident.

As regards the permanent way, the Report states that one of the major problems which faced engineers during 1948 was shortage of manpower, owing to the difficulty of obtaining and retaining men of the right type; but increased use was made of mechanical appliances to offset labour shortage and to speed the work of renewals. Further deterioration of the track has now been arrested and every effort is being made to restore conditions to pre-war standards. However, speed restrictions due to arrears of track maintenance and renewals remain one of the chief hindrances, and their number is still 25 per cent higher than pre-war. Improvement is largely governed by the supply of materials and concern is expressed at the possibility of a shortage of timber sleepers again causing an increase in restrictions and retarding recovery.

The report refers to the effect of climatic conditions on safety: first, to the five derailments in May and July due to track distortion in hot weather; secondly, to the severe storms in Scotland in August, and, thirdly, to widespread fog, when three collisions occurred on the same day in November.

Locomotive Interchange Trials on British Railways

It will be remembered that during 1948 the Railway Executive sponsored a series of intensive locomotive interchange trials between the various Regions of British Railways. The trials were designed to try out representative locomotive types of the former railway companies with standard loads, and as far as possible under identical conditions, both over the routes on which they were primarily designed to work and on other routes in various parts of the country.

In view of the public interest aroused by the trials and the possible usefulness of much of the information for reference purposes, the Railway Executive has made its report on the trials available to the Press. Copies of the report will, however, not be made generally available owing to the cost which would be involved in large-scale production.

We reproduce below part of a memorandum which accompanied the report—to which we hope to reply in a later issue of The Engineer.

British Railways, upon their formation in 1948, inherited four series of modern locomotive types, one from each of the former main line companies. Although each of these series was highly standardised within a single company, hardly any features or details were common from one company to another. Moreover, the suitability of the designs for running traffic over Regions other than their own was quite unknown.

In order to obtain the widest practicable benefit of engineering standardisation, it was proposed from the beginning that the Railway Executive would not continue to build four varieties of locomotive for each traffic duty. Rather, it proposed a single series of about twelve British Railways standard types which would each contain the best features of existing designs and which could have improvements and developments added to them through the years as experience and the ingenuity of the design staffs should indicate.

The immediate need was to examine the best of the locomotive types already existing and accordingly the Executive decided in January, 1948, that comparisons of the running performance of specified types should be obtained by means of trials in service on the line. Fourteen types of locomotive were each tried on selected routes on each of five Regions, ranging as far north as Inverness and as far west as Plymouth.

The tests were not intended to be a contest between locomotives of similar types, which it was appreciated had been designed, for the most part, to fulfil the requirements of their particular Regions. The results, therefore, do not disclose any dramatic or unexpected features, nor is it possible to declare a "winner." The use which the Railway Executive will make of the mass of data which has been accumulated can be summarised under two main headings:

(1) Since all the locomotives demonstrated their ability to operate the selected trains to the booked timings when operating on "foreign" routes differing widely in character from the "home" routes, the Railway Executive is satisfied that no limit need be placed on its proposals for standardisation by reason of suitability of particular locomotives for the routes over which they will have to work.

(2) The tests have indicated many features of design worthy of consideration for the new standard types and the drawing-offices are now examining closely their possible application. Examples are: (*a*) Use of the largest boilers which weight limits will allow to give ample reserve of power for all circumstances; (*b*) use of wide fireboxes in the larger engines for highest combustion efficiency; (*c*) firebox and ashpan arrangement to give best results with varying qualities of coal, and (*d*) adoption of design features to promote good riding and minimum wear and tear on the track.

Whereas individual tests of this kind have been carried out from time to time by all the former companies, this is the first occasion on which so comprehensive a series has been run. It has given the Railway Executive the opportunity of basing its locomotive design policy on known and recorded facts. It must be appreciated, however, that the tests outlined above only cover operating and performance features. These have to be supplemented for each locomotive by data on building and repair costs and on availability in daily service.

The National Coal Board's Report

The second annual report of the National Coal Board was published last week (H.M. Stationery Office, price 6s. 6d.). It is a document of considerable length, covering as comprehensively as possible the affairs of this country's nationalised coal-mining industry during 1948. Among the matters dealt with in the twelve main chapters into which the report is divided are coal production, technical developments in the mines, new collieries and reconstruction schemes, safety in mines, employment problems, costs, ancillary activities, and the Board's national plan for the industry.

The introduction to the report records that the most pressing needs in 1948 were to produce more coal, to improve its quality, and to cut costs, and it is noted that last year's output from the deep mines was 197,600,000 tons, an increase of 5·5 per cent over 1947. In addition, the output from opencast workings totalled 11,700,000 tons. Disputes of various kinds, however, led to 1528 stoppages of work during the year, and are estimated in the report to have caused a loss of coal output from the deep mines of 1,062,000 tons. More than half this total loss, it is stated, was caused by disputes about wages, while the second big cause of disputes during 1948 was disagreement over methods of working and colliery organisation. There were also a few disputes about the application of the five-day week agreement. Total inland coal consumption for the year was 192,294,000 tons, compared with 184,969,000 tons in 1947, and exports accounted for 16,000,000 tons. Distributed stocks at the end of the year were 14,567,000 tons, compared with 16,357,000 tons at the end of 1947.

The financial results of the Coal Board's operations show that at the end of the year there was a surplus of approximately £1,700,000, compared with a deficit of £23,250,000 at the end of 1947. The collieries, according to the report, made an operating profit of £16,200,000 last year, compared with a loss of £9,200,000 in 1947, but the profit from ancillary activities in 1948, £1,300,000, was lower than in the preceding year. Capital charges payable to the Minister of Fuel and Power were £15,600,000. Production costs last year are calculated to have been 45s. 6·6d. per ton of saleable output of coal, an increase of 4s. 3·6d. on 1947. Wages accounted for 28s. 3·8d. of the 1948 figure. The Board's capital expenditure over the year was £25,000,000, of which £21,000,000 was spent at the collieries, compared with £19,000,000 in 1947.

The manpower situation showed little improvement during 1948, and the Board did not succeed in adding more than 8300 to the mine labour force, which at the end of the year numbered 726,300. The report says that there was opposition from some branches of the unions to the employment of foreign workers; there was a shortage of houses, and many collieries could not find room for inexperienced labour. However, during the year, 16,000 men were trained as face workers. Re-assessment of miners' tasks, as provided for in the five-day week agreement, was continued, but the report observes that progress was disappointing in some parts of the coalfields. Much regular overtime was worked, though at fewer collieries as the year went on. Nevertheless, it is stated that absenteeism fell from 12·5 per cent in 1947 to 11·5 per cent in 1948, and output per manshift (all workers) increased from 1·07 tons in 1947 to 1·11 tons in 1948, and in the month of December exceeded 1·14 tons. The average earnings per manshift worked, including the value of allowances in kind, were 33s. 1·49d. last year for all workers, compared with 28s. 10·47d. in 1947.

In the chapter of the report dealing with technical developments in the mines, some description is given of the work undertaken in the extension of power-loading at the face, in roof control, and in the standardisation of equipment. It is also noted that, during 1948, twenty-three cleaning plants, with a capacity of 5,250,000 tons a year, were installed. The task of formulating the first "national plan" for the British coal-mining industry should be completed this year, the report says, but meanwhile many big capital schemes are proceeding. Descriptions of some of the projects are included in the report. A number of the schemes, it is added, were started or planned before nationalisation.

Welding Technique.—We have received from Braithwaite and Co., Engineers, Ltd., Crown Bridge Works, West Bromwich, Staffordshire, a brochure entitled "The Elements of Welding in Highway Bridges." This work consists of twelve data sheets covering fillet and butt weld details, size of welds, welded girders and girder connections, end bearings, cantilever frames, inspection of welds, and estimating electrode quantities. The information is reduced to plain elementary details expressed in terms of the workshop and drawing office, and is hoped to encourage the economy possible in this class of construction. The brochure is being distributed to County and Municipal Engineers throughout the country, and will be available on application without charge, to those engaged on highway works and the construction of steel bridges.

Power Supply in Sweden

THE production of power in Sweden is based almost exclusively on hydro-electric resources, which usually produce from 97 to 98 per cent of the total power requirements, the remainder being supplied by steam stations. The power supply is managed by the State Power Board, by municipal authorities, and by private companies. The State Power Board is responsible for about 40 per cent of the whole energy production and distributes power over an extensive network, both directly to the railways and large industrial plants, and to local distributing associations. The municipal authorities are responsible for 6 per cent of the total power production and private companies for the remaining 54 per cent, of which 20 per cent falls to industrial concerns which generate power mainly for their own requirements. The total installed generator capacity of the plants of the State Power Board is 1,000,000kW, of which 900,000kW are generated in hydro-electric stations (there being twenty large stations and several small ones), and 100,000kW are generated in a steam power plant at Västeras.

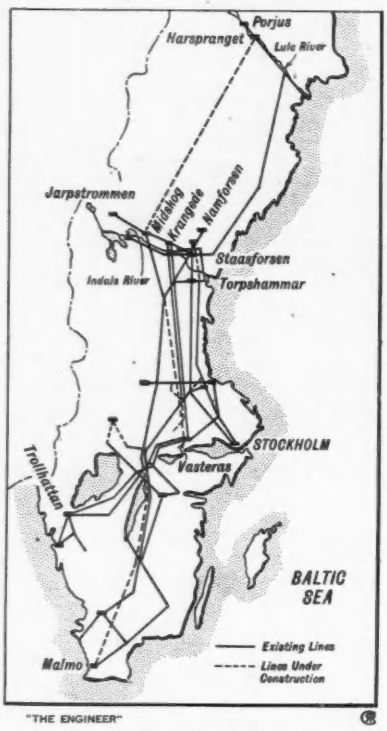


FIG. 1—SWEDISH TRANSMISSION LINE SYSTEMS

The total water power resources in Sweden may be estimated at about 150 thousand million kWh annually, with the energy economically available totalling some 50 thousand million kWh per year. In 1946 Sweden's total output of electrical energy amounted to 14,200 million kWh, corresponding to 2100kWh per head, a figure of the same order as the consumption in the U.S.A. and Switzerland, but less than in Norway and Canada.

The large sources of water power still undeveloped are to be found in the thinly-populated northern parts of the country, and it is mainly from these districts that new demands for energy must be met. Already 4000 million kWh are transmitted each year from the northern areas to central and southern Sweden, and the transmission distances are among the greatest in the world.

CONSTRUCTIONAL FEATURES

As a rule, Swedish waterfalls have a rather low head, often less than 150ft, but a comparatively large volume of water. Rocks on the surface or at a low depth usually provide good foundations for the construction of dams and power stations. Thus it is usually possible to build power stations entirely in rock, the head-race and the tail-race being taken through tunnels. Owing to the predominance of low heads, Francis or Kaplan turbines are now used almost exclusively, the latter type being particularly favoured by Swedish engineers.

Three main types of dams are in general use, namely, gravity structures, multi-arch dams and earth dams. After the first world war gravity dams were particularly favoured by Swedish engineers. The nature of the river waters, however, caused troubles in the concrete of these dams, whose life was thus rather short. This situation led to the development of a special technique, of protection against deterioration and ageing, by providing a watertight screen on the upstream face of the dam. For instance, the Stadsforsen dam, which is 82ft high, is protected by a watertight screen, 10in–14in thick.

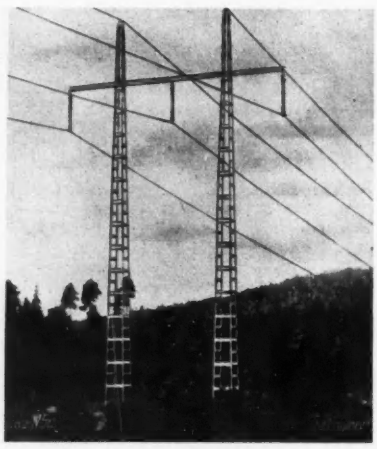


FIG. 2—220KV TRANSMISSION LINE

NEW POWER STATIONS UNDER CONSTRUCTION

At the present time a number of new power stations are under construction. The State has recently completed a plant at Nämforsen with a capacity of 45,000kW, and is building a station of 70,000kW capacity on the Ångerman River at Forsmo. The completion of a new plant at Höllesforsen on the Indal River is expected during the year and 120,000kW will be generated at this station, where an earthen dam 131ft high has been constructed.

The development of the largest natural source of water power in Sweden at Harspranget on the Lule River, about 30 miles north of the Arctic Circle, is at present being undertaken, and involves the construction of a large earth dam. This dam will be 140ft high and 4750ft long, with a slope of 1 in 1·75 on the upstream face and 1 in 1·25 on the downstream face. The watertight core of the dam is provided by a thickness of 13ft of clay and a reinforced concrete wall varying in thickness between 16in and 32in. A head of about 350ft will be utilised by three generating sets, each of a capacity of 88,000kW. The maximum capacity of the plant will be 260,000kW and the normal output 1750 million kWh per annum. It is anticipated that the first generator will be put into service by the end of 1950.

TRANSMISSION LINES

The primary transmission system, which is well developed in Sweden, consists of lines for voltages of 220kV, 132kV, 77kV and 55kV. These lines form a connected system from Porjus in the north to Malmö in the south, a distance of 825 miles as the crow flies. From Porjus there are also connections to Norwegian power stations at Narvik, while the system in the south is connected by cables under Oresund to the Danish power station on Själland. The 220-kV lines are used for the transmission of large quantities of energy from the northern to the southern part of Sweden. The 220-kV and 132-kV transmission lines are shown in

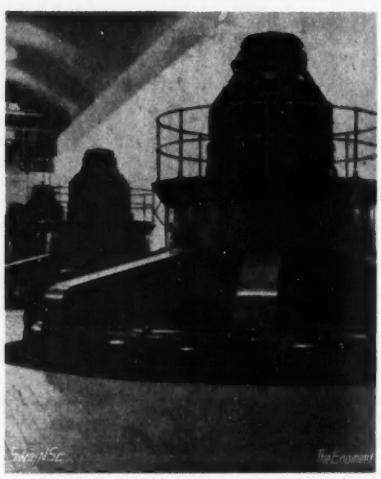


FIG. 4—KRANGEDE POWER STATION

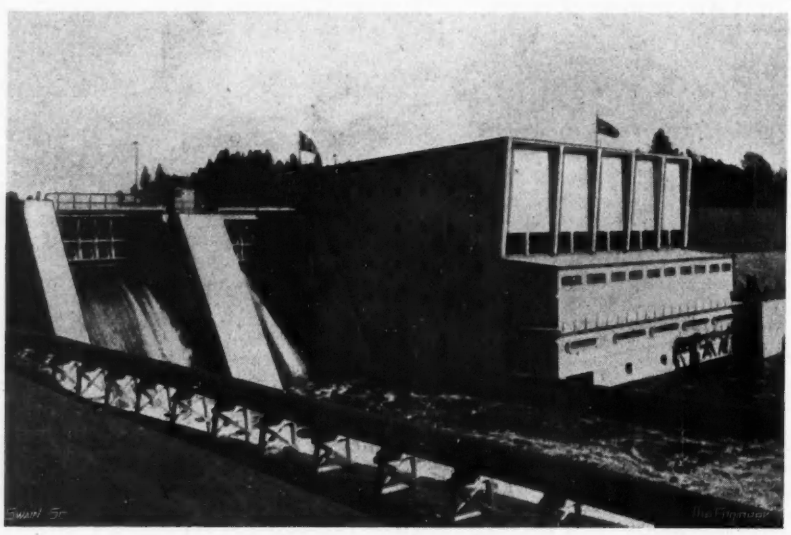


FIG. 3—TRARYD POWER STATION

Fig. 1, the transmission line shown under construction being the 380-kV line referred to below.

At the present time there are five main transmission lines. A number of new lines are under construction and within three years the number of main lines from Norrland (the northern territory) will be increased to six, and the 220kV system will be extended to Malmö. In this way the maximum transmission distance in the 220-kV network, which is 370 miles at present, will be increased to 560 miles. In addition, the State Power Board has decided to build a new transmission line, whose first section from Harspranget to Hallsberg is now under construction. This line will be 600 miles long, and is designed for 380-kV alternating current. It will be completed by the end of 1950, when the first machine is put into service at Harspranget.

From all these networks the power is stepped down to 11kV or 22kV, or in some cases to 33kV or 44kV. The transformer stations are situated about 30 miles apart and have a transformer capacity of some 10,000kVA; from these secondary stations electrical energy is supplied to the large industries, towns and municipalities, and also to electrified railways. A typical modern 220-kV transmission line carrying power from Norrland to south Sweden is shown in Fig. 2.

Existing Power Stations

The Sillre power station on the River Sillre, a tributary of the River Indal, utilises a head of 645ft, which is the highest in Sweden. This plant was also designed as a pumping station, so that it can be used to pump water into the storage lake upstream of the power station during periods when a surplus of power is available. Power is then generated during the peak load periods.

The Vargön power station, built in 1933, may be considered as a full-scale test model. It is situated at the mouth of the Vänner River and is equipped with two Kaplan turbines, each having a capacity of 14,000 h.p. The water head varies between 11½ft and 14½ft, and is utilised by means of a siphon. There are no gates, and the plant is operated by means of a vacuum pump and valves.

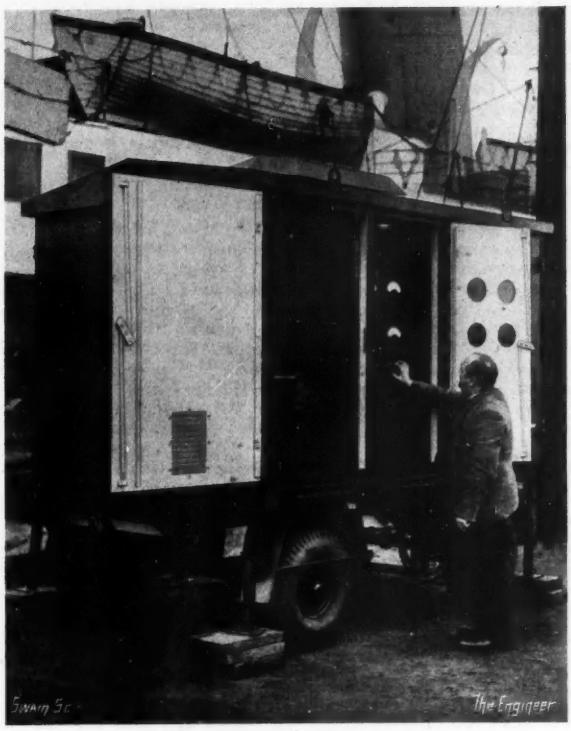
The discharge tunnel of the Krangede power station on the Indal River, which belongs to the Krangede AB power company, is said to be the largest unlined tunnel in the world. It has a cross-sectional area of 1250 square feet and is about a mile long. This station, which was completed in 1936, has a capacity of 210,000kW, and utilises a head of 197ft. It is built entirely in rock and contains six generating sets. An interior view of the underground machine hall is shown in Fig. 4.

Three State-owned stations at Trollhättan, Stadsforsen and Midskog each operate under a head of about 98½ft, and develop 220,000kW, 91,000kW and 95,000kW respectively. The first of these is one of the oldest State-owned stations and contains thirteen horizontal generating sets, which were installed in 1910; two new sets were installed in 1942 to bring the power output to the figure given above.

Other large Swedish power stations are situated at Järpströmen, Torpshammar and Porjus. The Järpströmen station belongs to the Stockholm Electricity Works and has an overall capacity of 115,000kW, with a head of 197ft. At Torpshammar, a head of 420ft is utilised by a 55,000-kW generating set, which is at the present time the largest in Sweden. Eventually a second set will be installed at this station. Both the Järpströmen and Torpshammar stations are built in rock, and both stations work mainly during peak load periods in the winter half-year. The power station at Porjus on the Lule River, was built by the State primarily for supplying power to the ore railway and the mines. Eight generating sets give a total capacity of 115,000kW and a further set is being installed to increase this figure to 135,000kW. The power station shown in Fig. 3 is the Traryd station, which is a modern plant situated on the River Lagan in the south of Sweden.

Mobile Motor Generators for Docks

To provide an adequate power supply on board ships in dock without the necessity for running the ship's auxiliary engines, the Southern Region of British Railways has placed an order with the General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, for seven mobile motor generator sets for service at Southampton, Dover and Folkestone. A typical unit in operation at Southampton is illustrated.



Mobile Motor Generator Set

Each set consists of a 50-kW motor generator mounted in a weatherproof kiosk on a pneumatic-tyred trailer, and weighs approximately 5 tons. When in use the trailer is supported on four jacks. Three wide doors are fitted in the kiosk to give access to all parts of the equipment, and interior illumination is provided by two 240-V lamps mounted in bulkhead fittings under the roof.

The units are arranged to take an incoming d.c. supply at the available mains voltage (Southampton 480V, Dover 500V, and Folkestone 420V). Five of the sets are designed for a 110-V d.c. output, and two for a 220-V d.c. output. The motor generators are fitted with compound and interpolar windings, and are designed to have a true level characteristic at all conditions of loading.

A four-panel switchboard mounted inside the kiosk is fitted with a 500-A circuit-breaker of the line contact type, and a contactor type starter with push-button control is provided for the motor. The incoming feeder is controlled by means of an ironclad switch fuse fitted with h.r.c. 200-A fuses, and the three outgoing feeders are similarly controlled.

Ships owned by the Southern Region are provided with a terminal box on the upper deck for receiving the cables from the shore, this box being connected through an isolating switch and circuit-breaker to the main bus-bars in the engine-room.

A New House Service Meter

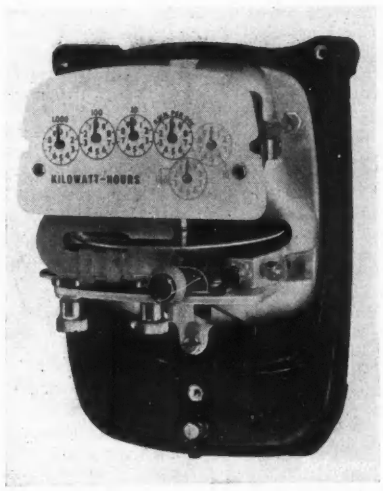
The single-phase house service watt-hour meter exhibited by Crompton Parkinson, Ltd., at the recent British Electrical Power Convention is an instrument designed for consistent accuracy under varying ambient temperature conditions, with a magnet system and overload compensator to ensure good performance over a wide range of load. A general view of the meter without its cover is reproduced below to show the accessibility of the milled adjusting screws. A smoothly-contoured, easily-cleaned plastic case houses the complete assembly.

The magnetic system of the potential and series elements consists of laminations interlocked to ensure that in every meter a fixed dimensional relationship exists between the pole tips.

A pressure die-cast aluminium-silicon alloy casting comprises the main frame which is fixed directly to the main mounting plate of the induction unit and is positively located by dowels to maintain correct relationship between the rotor disc and the magnet system. For inspection, cleaning or replacement of rotating parts, the main frame assembly is designed as a removable unit.

The duralumin rotor spindle is fabricated from hub and spindle blanks, force fitted together and machined as an integral unit so that all holes and diameters are truly concentric.

The hardened and polished steel pivot is rigidly fittep in a mount, which screws into the bottom end of the rotor spindle and is therefore removable. A recess in the rotor hub protects both the pivot and its associated bottom bearing, which is a synthetic sapphire jewel cup, cut at the correct optic axis. The jewel is mounted in a brass carrier which is spring mounted to a brass cap nut, and the assembly is screwed into a threaded sleeve adjustable on the bottom bearing boss of the die-cast frame and locked in position, so that when the jewel carrier is screwed into the sleeve the jewel is at the correct level to maintain all rotor clearances. The jewel carrier can be removed for cleaning and inspection and replaced without affecting the adjustment. Similarly the complete rotor can be removed and replaced without altering the mechanical or electrical adjustment and calibration.



The "B1" House Service Meter

Industrial and Labour Notes

British Overseas Trade

The "Accounts relating to Trade and Navigation of the United Kingdom," which were published last week by H.M. Stationery Office, show that the value of British goods exported during May was £151,405,748. That figure was about £14,000,000 higher than the April total, but was £8,600,000 lower than that recorded in March. There were twenty-six working days in May, and the daily rate of export was approximately 1·5 per cent higher than in April, which contained twenty-four working days. Allowing for changes in prices, May exports are estimated provisionally as being 153 per cent of the 1938 volume average, compared with 140 per cent in April, and 156 per cent in the first quarter of this year.

Although machinery exports again made a notable contribution to the month's total, they were about 10 per cent below the average for the first quarter of 1949. The total amount of machinery and parts sold overseas in May was 70,200 tons valued at £22,813,017. Exports of electrical machinery, boilers and boiler-house plant were lower than in some preceding months. There was, however, an increase in the exports of prime movers (not electrical), which totalled 6,300 tons. The number of cars and chassis exported during May was 23,024, a figure which, according to the Board of Trade, was the highest on record, apart from April, 1948. Exports of commercial vehicles and chassis totalled 8613, thus constituting a new record, but the export of agricultural tractors in May was not much more than half the first quarter's average.

Imports into the United Kingdom during May were, at a value of £194,827,684, the highest on record. Re-exports amounted, in value, to £5,609,275, so that the visible adverse balance at the end of last month was £37,812,661, compared with about £44,600,000 at the end of April. On an average, the adverse balance in the first three months of this year was £21,000,000.

Taxation of Trade Profits

In the course of his Budget speech in April, the Chancellor of the Exchequer intimated his intention to set up a committee to investigate certain matters relating to the taxation of trade profits. He has now appointed a committee consisting of Mr. J. Millard Tucker, K.C.; Mr. W. S. Carrington, Member of Council of the Institute of Chartered Accountants; Sir John Cater, formerly Chief Inspector of Taxes; Mr. H. Weston Howard, chairman of Hayward-Tyler and Co., Ltd.; Mr. W. W. Shepherd, chairman of Turner and Newall, Ltd.; and Mr. G. Woodcock, assistant general secretary of the Trades Union Congress.

The committee's terms of reference are "to enquire into the method of computing net trade profits for the purpose of charging them to income tax, and to consider the basis period to be taken in assessing the tax on the profits so ascertained; to enquire into the method of computing net profits for the purpose of charging them to Profits Tax; and to report upon any alterations of the tax law which may be desirable."

Joint Consultation in the Nationalised Industries

The Trades Union Congress has been collecting the views of constituent unions on the structure and conduct of nationalised industries, and has made some observations this week on joint consultative machinery within those industries. Some unions, the T.U.C. says, have reported that, in the nationalised industries, the machinery for consultation is not always used before policy decisions are reached, and to remedy that, the T.U.C. General Council intends to press for the promotion and extension of schemes of training in the purpose and methods of joint consultation for both management and unions.

Joint consultative machinery in the nationalised industries, the T.U.C. urges, should not become "a rubber-stamp for decisions, a mere channel of information, or a method of securing workers' co-operation on relatively minor matters without discussing major policy." At the same time, it considers that machinery leading to consultation, decision and action, in that sequence, in no way cuts across the accepted function of management. The T.U.C. adds that affiliated unions have expressed their general satisfaction with the present formal procedure for joint consultation within the nationalised industries.

Engineering Wages

The conference of the Amalgamated Engineering Union's National Committee continued at Scarborough throughout last week, and on Thursday and Friday devoted a good deal of time to discussing the proposals for a new wages structure, recently formulated by the Confederation of Shipbuilding and Engineering Unions. The proposals, which were summarised in these notes on May 27th, provide for six grades of workers in the engineering industry, each with a national minimum ranging from 96s. for labourers to 120s. plus special rates for certain classes of craftsmen.

There was considerable criticism of the proposals by various members of the A.E.U. National Committee, and on Thursday a resolution was framed instructing the executive council to press the Confederation to make an immediate claim for a £2 a week increase for all workers in the shipbuilding and engineering industries. Such an increase, the resolution urged, should become operative as from the date of application, and should be met from profit and not added to the price of consumer goods. When the conference resumed on Friday last, an amendment was proposed and carried that the claim should be for an increase of £1 a week. Summing up the discussion, the president, Mr. J. Tanner, pointed out that the pressing of this claim immediately might lead to consideration of the new wages structure being deferred.

The Post Office Engineering Union, which has recently concluded its annual conference, announced last week that it had decided to press for a wage increase of 15s. a week for its 40,000 members.

Wages in the Electricity Supply Industry

The British Electricity Authority stated at the end of last week that a meeting of the National Joint Industrial Council for the Electricity Supply Industry had been called for yesterday (Thursday) to consider matters raised by District Joint Industrial Councils concerning the national wages agreement concluded on May 31st. That agreement provided for a wage increase of 1½d. an hour for all grades of manual workers, and stated that where excess payments were being made over and above those provided in the January, 1947 national agreement, such excess payments should be merged in the increase except where it was decided, through the negotiating machinery, that the continuance of the additional payments was justified.

The British Electricity Authority has now made it clear that, whilst the vast majority of workers will receive an increase in their existing wages, no individual will suffer a reduction in wages under the new agreement, nor will there be any change in the additional payments, except through the machinery of the National Joint Industrial Council. That course, the B.E.A. emphasised, was strictly in accordance with the arrangements agreed to by the trade unions, and could not be affected by threats of withdrawal of labour.

The International Tin Study Group

The fourth meeting of the International Tin Study Group concluded in London on was issued summarising the discussions and the decisions reached. Statistics which the Group has prepared show that tin production between now and 1951 is estimated as follows:—170,000 long tons in 1949, 190,000 tons in 1950, and 205,000 tons in 1951. Those figures have been based on the assumption of no fundamental alteration in economic, social and political conditions in the producing territories. Consumption for commercial purposes has been put at 138,000 tons in 1949, 158,000 tons in 1950, and 162,000 tons in 1951. The figures given by the Group, it should be stated, take no account of production or consumption in the U.S.S.R.

The statement went on to say that the estimates indicated an existing and growing excess of tin production over commercial consumption, but took no account of purchases for non-commercial consumption. It was not possible to determine to what extent and for what period of time such purchases would be effective in averting disequilibrium, but the Group understood that "equilibrium for an appreciable period ahead" might be maintained. At the same time it was considered that a burdensome surplus of the kind which could be regarded as justifying the conclusion of an International Commodity Control Agreement might well arise within the next five years. The Group accordingly decided to set up a working party open to all member Governments. This working party has been directed to prepare a statement on the position and prospects of the tin industry which would serve as a basis for member Governments to determine whether they should ask for an International Commodity Conference to be convened by the Secretary-General of the United Nations.

Disposal of Surplus Non-Ferrous Metals

The Ministry of Supply announces that the functions of the Disposals Section of the Non-Ferrous Metals Directorate will shortly be transferred to the Contracts Division of the Ministry. From July 1st, inquiries about Government-owned surplus non-ferrous metals (scrap and semi-manufactured) should be made in the first instance to Ministry of Supply, Contracts Division (Disposals/R.E.7), Great Westminster House, Horseferry Road, London, S.W.1, and payment for surplus non-ferrous metals should be made to Ministry of Supply, A.G.42(d), Adelphi, John Adam Street, London, W.C.2, instead of to Rugby. These changes apply only to metal sold as surplus and do not affect virgin non-ferrous metals, which will continue to be dealt with by the Non-Ferrous Metals Directorate, 20, Albert Street, Rugby, (telephone No. Rugby 2131).

Railway Wages

A special delegate conference of the National Union of Railwaymen was held on Tuesday last to consider the latest offer made by the Railway and London Transport Executives in response to the wage claim advanced a few weeks ago by the union. This claim was for a general wage increase of ten shillings a week, with additional rates for Saturday afternoon work. The Executives have stated that they cannot meet the demand, but they have offered some improvements in the wages of the lowest paid railway workers. Details of this offer have not been made public, though it has been suggested that it proposes increases of from one shilling to three shillings a week in the wages of about 160,000 workers. At Tuesday's conference, the Executives' latest offer was rejected by the delegates on the ground that it was "totally inadequate," and a resolution was passed ordering a "go-slow" campaign among N.U.R. members throughout the country until the demands were met in full. This "go-slow" or "working to rule" action is timed to begin at midnight on Sunday next. When discussions on the wage claim between the N.U.R. and the Railway Executive were last adjourned, it was stated that they were to be resumed yesterday (Thursday).

French Engineering News

(From our French Correspondent)

Yet another increase in certain electricity tariffs is expected in order to finance equipment work. Since a simple increase in consumption tariffs might have been unpopular, the income will be drawn from new installations. The *Journal Officiel* (French Hansard) has announced that as from July 1, 1949, 1000 francs per kW will be payable by subscribers for new installations. At the same time, all industrial and commercial consumers with power of less than 11kW will pay 1500 francs per kW annually, and 600 francs per kW will be paid by domestic users having 11KW or over. In addition, if the subscriber exceeds maximum power contracted during December, January or February, the 1500 or 600 francs increase will be applied to the maximum power attained, for a period of four months. It is indicated that this tax is a temporary measure designed to finance equipment work.

* * *

An urgent advance of 400 million francs has been demanded by the nationalised aircraft construction companies to meet urgent payments and particularly salaries. General losses on sales and services were estimated at 815 million francs on December 31, 1948, sales losses being attributed to those plants where reconversion has taken place—Colombes and Fourchambault.

The nationalised companies are generally suffering from insufficient capital and lack of essential working funds which has weighed down on exploitation accounts. The Secretary of State has indicated that a manufacturing programme to be spread over several years is being arranged so that the industry will know the extent of credits allocated over a long term. As yet no orders, apart from the "Marcel-Danaut 315," have been placed. Prototypes being tested have yet to be accepted by the commission recently created, and orders placed according to credits allocated. According to the Bill introduced by the Surleau Commission, only those factories strictly essential to aeronautic construction will be retained; the other converted factories will be transferred either to the Ministry of Industry and Commerce or to private enterprise.

* * *

A new coking plant being planned for construction at Pontcharra (Loire) will be one of the most important in Europe. It will comprise four fifteen-day batteries with a capacity of 21 tons per unit. About 1200 tons of fuel will be used daily, the coal being brought direct to the coking plant by ropeway from the Pigeot mines and by special lines from the Charles and Couriot pits.

* * *

A general review of the mechanical and electrical industries in April shows that generally speaking supplies of steel products were satisfactory, but that non-ferrous metals are still short. There is a shortage of all copper alloys, and zinc supplies are still insufficient to meet requirements. Supplies of electric power have improved, but are still holding up production, as the needs of large consumers have increased and cannot always be satisfied. Coal needs are generally covered by allocations, but in the Nord, certain factories will have to stop work at the end of June unless further supplies are available. The situation is unlikely to allow stocks to be reconstituted for next winter. Delays in coke deliveries are also holding up certain foundries while those in the East complain of the poor quality Ruhr coke.

* * *

Energie des Mers, a company established some months ago, with a view to constructing a low-pressure plant in Morocco, is preparing plans for a 7000-kW plant at Abidjan, which will comprise two 3500-kW groups. Various experiments are now taking place and the heating of water by solar rays is the subject of an experiment now nearing completion at Dakar. The plant will cost between 2 and 2½ milliard French francs, and work, which will begin before the end of the year, will be spread over two and a half years.

Notes and Memoranda

Rail and Road

FLOODS IN THE NORTH.—A short documentary film, entitled "Floods in the North," has recently been made by British Railways. The film depicts the measures taken to restore railway communications and to repair extensive damage caused by the floods in south-east Scotland last year. The film, which runs for about twenty minutes, is intended both as a record of the way in which the various problems were tackled and as a semi-instructional film for railway technical staffs. Various phases of the work which are shown in the film include the erection of temporary trestle bridges, the driving of steel sheet piling used in the construction of bridge foundations and to prevent erosion of embankments, and the clearing of debris caused by landslips.

COLOURED ROADS.—The Road Research Laboratory has been investigating the possibilities of using coloured asphalt for road construction. Experiments carried out have produced asphalt in colours such as cream, yellow, red, green and blue at a cost not very much greater than that of ordinary asphalt. The Department of Scientific and Industrial Research, in reporting the experiments, says that coloured asphalts made from pigmented "albino" bitumens have been used for many years, but are much more costly than ordinary asphalt. Only dark shades can be produced because of the intrinsic darkness of the bitumen. The new bright colours are made by using a proprietary brand of resinous binder known as "Cados." It is more translucent than albino bitumen and its cost compares favourably with that of ordinary bitumen. Using this binder and a clean white aggregate such as calcined flint it is possible to obtain a fine white asphalt which can be easily coloured with any desired pigment. The addition of 4 per cent of titanium oxide, for instance, gives a creamy white. Effective reds and yellows, greens and blues have been made with as little as 2 per cent of other pigments. The materials have not yet been tested under traffic, but a small area in four colours at the Laboratory is giving promising results. Trial areas on roads and footpaths are being planned and the results of large-scale trials on public roads should be available in a few months' time.

Air and Water

THE THURLOW NAVIGATION AWARD.—The Thurlow Navigation award of the U.S. Institute of Navigation has been made this year to Mr. Donald H. Sadler, Superintendent of H.M. Nautical Almanac Office. The award, which was established in 1946 in memory of the air navigator, Colonel Thomas L. Thurlow, is given annually to the person who, in the opinion of a representative selection committee, contributes most to the science of navigation.

RIVER BOARDS.—The Minister of Agriculture stated recently, in reply to a question in Parliament, that considerable progress had been made with the definition of river board areas, which was the first stage required by the River Boards Act, 1948. The River Board Areas Consultative Committee, he said, had nearly completed its examination of suitable boundaries, in consultation with all the catchment boards, fishery boards and councils of counties and county boroughs concerned, and had submitted a number of recommendations. The statutory procedure for defining areas and for establishing boards and transferring functions to them would take time but, the Minister added, those processes would be carried through as quickly as the circumstances of each area allowed.

VICKERS "VISCOUNT" SECOND PROTOTYPE.—It is announced that the second "Viscount" prototype will be powered by two Rolls-Royce "Tay" jet engines. Construction is well advanced and it is hoped that flight trials will begin before the end of the year. The aircraft is being built for the Ministry of Supply, not as a potential airliner, but solely for research and development purposes. No further details of the "Tay" engine may be given at present. Meanwhile, the first "Viscount" prototype, which completed the initial phase of its flight trials in May, is being fitted with its pressurisation system. Increased interest has been shown in the "Viscount" by airline operators since the announcement of the "Viscount 700," an enlarged version capable of carrying 40 or 53 passengers. This development has been made possible by the increased power of the Rolls-Royce "Dart RDa3" propeller turbine engines. Work was begun some time ago on the first of the "700s," but no estimate can yet be given of the date of the first flight.

Miscellanea

BRITISH STANDARDS INSTITUTION.—The annual general meeting of the British Standards Institution will be held on Wednesday, July 27th, at 3 p.m., in the Council Room at 24, Victoria Street, London, S.W.1.

IRON AND STEEL (No. 72) ORDER.—The Minister of Supply has made the Control of Iron and Steel (No. 72) Order, which came into operation on June 28th. It increases the maximum prices of spiegeleisen and rainwater and soil goods.

PROPERTIES OF MONEL AND INCONEL.—Two recent publications of Henry Wiggin and Co., Ltd., Wiggin Street, Birmingham, 16, deal, respectively, with the properties and applications of "Monel and K Monel," and "Inconel." They include notes on the corrosion-resistant qualities of the metals and tables of physical constants, mechanical properties, and temperature effects.

JOULE'S WATER-FRICTION APPARATUS.—One hundred years ago, in June, 1849, James Prescott Joule announced the results of extensive researches carried out in Manchester, in which he found that the expenditure of energy, in whatever form, was always accompanied by the production of a corresponding amount of heat. The original water-friction apparatus, with which Joule made an accurate determination of the mechanical equivalent of heat, is preserved at the Science Museum, South Kensington, London, S.W.7, where it will be on exhibition until July 21st.

PERMITTED EXPLOSIVES FOR MINES.—The Minister of Fuel and Power announces the introduction of permitted explosives which, without sheathing, have been certified, after appropriate tests, to be not less safe than an equivalent sheathed explosive of the same group. These explosives are made by incorporating materials which have a similar effect to the materials normally used and applied as external sheathing. An explosive of this type will be subject to the official test for permitted explosives and also to special tests by the Ministry's research staff. It will be accorded the distinguishing code lettering "Eq. S.," to be clearly marked on each cartridge and on the wrappers of the packages, and will be distinguished in the same way in the published List of Permitted Explosives.

TERMINAL UNITS FOR CABLE AND WIRELESS NETWORK.—An order for twenty-two radio-telephone terminal units has been placed by Cable and Wireless, Ltd., with Marconi's Wireless Telegraph Company, Ltd., for installation at various points of the world-wide Cable and Wireless communication system. These terminal units are produced by the Marconi Company in collaboration with Siemens Brothers and Co., Ltd., and are specially designed to minimise the special problems of linking radio and land-line transmission. The equipment ensures stability of signal and provides facilities for controlling the signal level, for discriminating against line and radio noises, and for rendering conversation unintelligible to unauthorised listeners. Full alarm and testing facilities are included, the terminal units can be remotely controlled and a number of terminals can be handled simultaneously from a central control.

WHITWORTH SCHOLARSHIPS.—Details of the Whitworth scholarships in engineering to be offered for competition in 1950 have been announced by the Ministry of Education. Two senior scholarships and five scholarships will be available for candidates of British nationality who are not more than twenty-six years of age. They are required to have had practical experience in engineering before taking up an award. Whitworth senior scholarships are for candidates who possess an engineering degree or a Higher National Certificate with two distinctions, or are in the last year of a course leading to one of those qualifications. The annual value of the awards is £325 and they will be tenable for two years for a course of further training in industry or for research work. Candidates are required to submit a thesis on one of a number of specified subjects. Whitworth scholarships are for students whose further education has been limited to evening classes. Their annual value is £200, though that amount may be increased depending on the cost of the course and the means of the holder. They are tenable for three years either in industry or at an educational establishment. They will be awarded on the results of the Whitworth Scholarships Examination to be held in April, 1950. Further details of the awards may be obtained from Heads of Colleges of Further Education, or from the Ministry of Education, Curzon Street, London, W.1. The closing date for the competition is January 15, 1950.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Incorporated Plant Engineers

To-day, July 1st.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, "Canteen Equipment," E. Green, 7.30 p.m.

Institution of Mining and Metallurgy

Wed., July 6th.—The Royal Institution, 21, Albemarle Street, London, W.1, "The Effect of Impurities on the Properties of Metals," C. H. Desch, 5 p.m.

Thurs., July 7th, to Fri., July 8th.—Royal Institution of Chartered Surveyors, 14, Great George Street, Westminster, S.W.1, Symposium on the Refining of Non-ferrous Metals, 10 a.m. to 5 p.m. each day.

Iron and Steel Institute

Tues., July 5th.—4, Grosvenor Gardens, London, S.W.1, "The Martensitic Transformation," Dr. Morris Cohen, 5.30 p.m.

Royal Agricultural Society

Tues., July 5th, to Fri., July 8th.—Royal Show at Shrewsbury.

Underground Mining Machinery Exhibition

Thurs., July 7th, to Sat., July 16th.—Earls Court, London, S.W.6.

Codes of Practice

The Codes of Practice Committee for Civil Engineering, Public Works and Building and Constructional Work is under the ægis of the Ministry of Works. Codes are issued on behalf of the Committee by the British Standards Institution, 24–28, Victoria Street, London, S.W.1.

MECHANICAL REFRIGERATION

Code 406. The Council for Codes of Practice for Buildings has now issued, as drafts for comment, Part B, "Thermal Insulation," and Part C, "Safety," of Code 406, "Mechanical Refrigeration,"* each prepared on the council's behalf by a committee convened by the Institution of Mechanical Engineers. Part B deals with the design, construction, installation, inspection and testing of thermal insulation as applied to cold-stores, buildings and refrigerating plant, to maintain a temperature below the ambient.

A brief explanation of the basic principles of thermal insulation is given by way of introduction, and a short list of definitions provided. Attention is drawn to the need for consultation, in the early design stages, between all interested parties, to co-ordinate the installation of the refrigerating system with the other services such as electricity, gas and water supplies and further, to ensure proper assessment of soil conditions, foundation requirements and other factors. The dangers of structural damage due to expansion and contraction and to the yet more serious damage likely to be caused by frost heave are pointed out, and advice given on how to circumvent them. Guidance is given on the calculation of the thickness of insulation required, and to facilitate this the code includes tables setting out recommended minimum resistances for various temperature differences, the characteristics of bitumen (for erection purposes), the characteristics of some commonly used types of insulating materials and the water-vapour transmittance of various materials and finishes. A quadruple graph is also provided from which may be determined, in appropriate cases, the insulation resistance required on the cold side of the vapour seal to prevent condensation on the hot side. Another useful table summarises, for each month of the year, the temperature and humidity observations, over a period, at each of eight meteorological stations in the United Kingdom. The code includes recommendations covering the prevention of air leaks, water vapour penetration, mechanical failure of insulation and rot in timber.

Advice on pipe insulation includes a table of recommended minimum thicknesses of insulation, and the design and fitting of pipe supports is also discussed. Internal finishes to insulation are dealt with in some detail, followed by a number of points relating to work on a site, inspection, testing and maintenance. Apart from the tables already mentioned, the appendix includes a convenient summary of those clauses which are of particular interest in relation to other Codes of Practice.

Part C of the code deals with those safety features, in the design and installation of refrigerating plant, which are considered necessary to safeguard life, health and property. The recommendations cover mechanical strength, devices to relieve excessive pressure, protection against damage due to low evaporating temperatures or to the freezing of cooling liquids, safety of electrical installation, provision of alarm signals, choice and storage of refrigerants and precautions against fire and accidents. The Section dealing with inspection and testing includes a table of minimum test-pressures, at works, for various components of the plant, and recommendations for minimum test-pressures for the complete system after erection on site. The physical, toxic and explosive properties of the commoner refrigerants are set out in an appendix. Each document carries the usual warning that during the present abnormal conditions it may not be practicable to take full advantage of all the recommendations; each is in draft form and subject, before final publication, to amendment in the light of comments received. Comments, which are invited and welcome, should be submitted by August 3, 1949.

Code 406, "Mechanical Refrigeration": Part B, "Thermal Insulation," proof reference CP (B) 862, 3s., post free; Part C, "Safety," proof reference CP (B) 863, 2s., post free.

* Part A, "Performance Testing," is in preparation and will be published shortly.

CHOICE, INSTALLATION AND MAINTENANCE OF ELECTRIC WIRING SYSTEMS IN BUILDINGS

Code 321.101. This code was previously issued as a draft for comment and, in the light of comment received, has been revised by a committee convened by the Institution of Electrical Engineers. It should be read in conjunction with Code 321, "Electrical Installations—General," and gives guidance on the choice, installation and maintenance of electric wiring systems for power, lighting and heating circuits in buildings. Recommendations given cover the installation of wiring systems during the construction, or after the completion of buildings, and also additions or alterations to installations already existing. The code deals with all reliable wiring systems and with their selection under headings of the various types of building to be served (including dwellings, offices, schools, factories and department stores). It indicates choice according to the functional requirements of the buildings, taking into consideration questions of safety, cost, durability and appearance. The recommendations are framed having in mind the possibilities of extensions, or changes being made from time to time. Guidance is given on the location of cables, their protection from moisture, heat and other causes of deterioration, and their segregation from other services. Detailed advice is also included on the installation of various wiring systems with recommendations on temporary installations. The appendices to the code include tables showing the maximum number of cables which can be housed in various sizes of conduit, the maximum spacing of clips, saddles, &c., and a comprehensive list of types of systems for use in industrial premises. The code carries the usual warning that during the present abnormal conditions it may not be practicable to take full advantage of all the recommendations made in it. Price 4s., reference CP 321.101 (1949).

Personal and Business

MR. R. W. FOOT has been appointed an additional deputy chairman of Powell Duffryn, Ltd.

MR. G. E. SAVORY, A.M.I.Mech.E., has been appointed sales director of Ruston-Bucyrus, Ltd.

MR. W. J. BORROWMAN has been appointed manager of the diesel department of Sulzer Bros. (London), Ltd.

COMMANDER J. H. F. KENT, R.N. (ret.) has been elected president of the Retread Manufacturers' Association.

MR. L. W. BALDWIN has been appointed export manager of Simplex Electric Company, Ltd., Oldbury, Birmingham.

MR. R. A. WEST, B.Sc. (Eng.), A.M.I.E.E., has been elected a director of the Igranic Electric Company, Ltd., Bedford.

FILTRATORS, Ltd., states that its address is now 92, Seymour Place, London, W.1 (telephone, Paddington 6611; telegrams, "Filtrators, Wesdo, London").

MR. S. B. HAINSWORTH, managing director of J. H. Fenner and Co., Ltd., has been appointed chairman of the Association of Solid Woven Belting Manufacturers.

ROCKWELL MACHINE TOOL COMPANY, Ltd., Exhibition Grounds, Wembley, announces that it has acquired the sole selling rights in the United Kingdom for the 25-ton power press manufactured by Sentinel (Shrewsbury), Ltd.

BULL MOTORS (E. R. and F. Turner, Ltd.), Ipswich, has transferred its London office to Wellington House, 125–130, Strand, W.C.2 (telephone, Temple Bar 9246). The company announces that Johnson Electrical Services, Ltd., 14, Langport Road, Weston-super-Mare, has been appointed its West of England agent.

LIEUT.-COLONEL SIR ALAN MOUNT has been appointed consultant to the Railway Executive on matters concerned with safety measures for British Railways. Sir Alan's forthcoming retirement from the position of Chief Inspecting Officer of Railways, Ministry of Transport, was announced in our issue of June 10th.

MR. H. M. GOODY has been appointed managing director of Cantie Switches, Ltd., which has now moved from Chester to New Ferry, Bromborough, Cheshire. Since 1941 Mr. Goody has been joint managing director of the associated company, Brookhirst Switchgear, Ltd., but is relinquishing that office on taking up his new appointment.

MR. R. A. CARDER has been appointed chairman of the Anglo-American Oil Company, Ltd., in succession to Mr. David A. Shepard, who has resigned to become executive assistant to the President of Standard Oil Company. Mr. Carder will continue to serve as managing director of the Anglo-American Oil Company, Ltd., which states that Mr. Leonard Sinclair has been appointed an additional managing director. Mr. Howard W. Page has been elected to the board.

Technical Reports

Technical and Economic Comparison Between D.C. and A.C. Transmission of Power, and Problems for Research and Development of D.C. By Dr.-Ing. F. Busemann. The British Electrical and Allied Industries Research Association. (Ref. Z/T77). Price 18s., postage 4d.—This report summarises comparative economic considerations regarding h.v. transmission problems for a.c. and d.c. which have been treated in greater detail in earlier reports, viz., Ref. Z/T67–71 inclusive, and other Committee papers.

Investigation of a Sample of Domestic Two-Part-Tariff Consumers. By P. Schiller, Dipl.-Ing., M.I.E.E., and W. A. Pridmore, B.Sc. The British Electrical and Allied Industries Research Association. (Ref. K/T127). Price 6s., postage 3d.—This report gives survey data for the sample of two-part-tariff consumers selected from former undertakings in and around London, which link up with the comprehensive returns in Report Ref. K/T125. A graph of the distribution of annual maximum demand amplifies information contained in Report Ref. K/T122. The report includes an analysis of various quantities on which domestic two-part-tariffs are based.

Production, Flow and Effects of Harmonics in A.C. Transmission Networks. By H. R. J. Klewe. The British Electrical and Allied Industries Research Association. (Ref. M/T99). Price 6s., postage 3d.—The report deals with the production, distribution and effects of balanced and unbalanced harmonics in power systems. Induced earth currents, unbalanced currents resulting from capacitive unbalances, and some effects of electrically long lines are discussed, together with some consequences, in the a.c. and d.c. systems, of the suppression of harmonics by the use of rectifier groups with shifted phases. In each case the influence on telephone interference is considered. This report is based largely on information which has also been used for the preparation of a paper of a more detailed and scientific character by Dr. W. G. Radley, Controller of Research at the General Post Office, and Dr. S. Whitehead, Director of the Electrical Research Association, which paper is now in process of publication by the Institution of Electrical Engineers.

Dielectric Properties and Premelting in Ketones. By V. Daniel, Ph.D., Dr. Nat. Sci. The British Electrical and Allied Industries Research Association. (Ref. L/T200). Price 6s., postage 3d.—This report covers the first part of an investigation which was initiated on the basis of Frölich's theoretical treatment of the properties of long-chain substances, in particular by E.R.A. Report Ref. L/T147 (published in "Proc. Roy. Soc. A.," 185, page 399, 1946). The structure and properties of long-chain paraffins and their derivatives are of interest because they can be prepared with varying chain lengths and because side groups can be substituted at different parts of the chain. Just below the melting point the structure of some of these compounds loosens in a way which is sometimes called "premelting," and this affects a number of physical properties. In this investigation the phenomenon of premelting is studied by measuring dielectric and other properties and a qualitative theory in explanation of the phenomenon is developed. The possible application of the work to the study of premelting in plastics is discussed.

A Seven-Day Journal

Transmission Lines in Argyll and Inverness

THREE more schemes of the North of Scotland Hydro-Electric Board covering the erection of overhead transmission lines from Fannich to Boat of Garten and from Fasnakyle to Beauly in the north, and from Shira, Argyllshire, to Inveruglas in Dunbartonshire, have been confirmed by the Secretary of State for Scotland, the Rt. Hon. Arthur Woodburn, M.P., and were presented to Parliament yesterday. The Fannich to Boat of Garten line (Scheme No. 10) will carry electricity generated at the Hydro Board's Fannich project to link up with the existing transmission lines near Boat of Garten. This scheme is estimated to cost £800,000 and includes the erection of a transforming station near Beauly, where it will join the other new transmission line from Fasnakyle to Beauly (Scheme No. 14). The latter scheme will carry electricity generated at the Hydro Board's Affric project and is estimated to cost £380,000. The new transmission line from Shira in Argyllshire to Inveruglas in Dunbartonshire (Scheme No. 21) will carry electricity generated under the Hydro Board's Glen Shira project at the head of Loch Fyne to the transforming station at Inveruglas and thus to the Central Scotland Grid. The estimated cost of this line is £190,000. Amenities of the various districts were considered and the proposals and recommendations of the Amenity Committee were made effective except that, for technical reasons, the Board was unable to accept the Committee's recommendation that only one line of towers should be erected on part of the Fannich to Boat of Garten line between Grudie Bridge and Beauly, instead of the two lines proposed. Objections were lodged in the case of the Fannich to Boat of Garten lines but these were later withdrawn. No objections were lodged against the two other schemes. Fuller details of the three schemes are given in recently published White Papers, copies of which are available from H.M. Stationery Office, 13a, Castle Street, Edinburgh, or through any bookseller, price 1d. each.

Gas Turbine Installation for Coventry Gas Works

IT is just announced that an order has been placed with Spencer-Bonecourt, Ltd., of London and West's Gas Improvement Company, Ltd., of Manchester, by the West Midland Gas Board, for a gas turbine driven alternator, which will work in conjunction with the latest installation of Glover-West continuous vertical retorts in the Foleshill Gas Works at Coventry. A heat-interchanger will be interposed in the waste gas flue, and the gases which will enter at about 1472 deg. Fah., will be reduced to 887 deg. Fah. before being passed on to a Spencer-Bonecourt waste-heat boiler, which will generate process steam for the retorts. The gas turbine is an eight-stage machine, operating on the closed cycle principle, and it is being constructed at Clydebank by John Brown and Co., Ltd. The air from the interchanger will enter the turbine at about 1112 deg. Fah. It leaves the turbine at approximately 680 deg. Fah., and passes to a contra-flow regenerator, in which the air from the air compressor is reheated before entering the main heat-interchanger. The compressor will be a five-stage centrifugal type machine, of John Brown's design, with intercooling between the second and third stages. The air leaving the regenerator on the exhaust side of the circuit will be cooled down to about 77 deg. Fah. before it enters the low pressure compressor. The alternator is a 700-kW machine and is designed to develop some 600kW, which will be for disposal, after allowing for auxiliaries. The alternator will feed directly into the mains of the Coventry electricity supply. A feature of this new plant is that it has been designed to operate well within accepted temperature limits, giving, it is expected, a long life, with long-running periods. This system of waste heat recovery by a combination of electricity generated by a gas turbine-driven alternator set, together with the production of process steam for works purposes, is covered by Spencer-Bonecourt-Gregson patents.

National Research Development Corporation

ON Thursday, June 30th, it was announced by Mr. H. Wilson, the President of the Board of Trade, that he had appointed the following as members of the National Research Development Corporation: Sir Percy Mills, of W. and T. Avery, Ltd., of Birmingham, Chairman; the Earl of Halsbury, Research and Works Manager of the Decca Record Company, Ltd., Managing Director. The other members are Professor P. M. S. Blackett, Langworthy Professor of Physics in the University of Manchester; Sir John McLean Duncanson, of the Lithgow's Group, Port Glasgow; Sir Edward Hodgson, Principal Finance Officer at the Board of Trade; Mr. W. E. P. Johnson, managing director of Power Jets (Research and Development), Ltd., and Sir Edward de Stein, a partner in the banking firm of Edward de Stein and Co. The functions of the Corporation as defined in the Development of Inventions Act, 1948, are as follows: to secure where the public interest so requires, the development or exploitation of inventions resulting from public research, and of any other invention as to which it appears to the Corporation that it is not being developed or exploited or sufficiently developed or exploited. The Act moreover, empowers the Corporation to acquire, hold and dispose of and to grant rights, whether gratuitously or for consideration, in connection with inventions resulting from public research and, where the public interest requires, in connection with inventions resulting from other sources. According to the Act the expression "invention," includes any new process or new technique, and shall be construed without regard to whether or not a patent has been or could be granted. The expression, "public research," means research that is carried out by a Government department or other public body or any other research in respect of which financial assistance is provided out of public funds. The Corporation is thus empowered to develop and exploit inventions over which the Government has the right of proprietor and also those inventions emanating from private sources, which are likely to be of benefit to the community and are not being adequately used already. For that purpose the Corporation may borrow up to £5,000,000 from the Treasury, within five years of its establishment. It is expected, however, to repay such loans, and to pay its way in the long run. The address of the Corporation is I.C.I. House, Millbank, London, S.W.1.

Council of British Manufacturers of Petroleum Equipment

AT the recent Seventh Annual Meeting of the Council of British Manufacturers of Petroleum Equipment, Mr. E. F. E. Howard, the chairman of the Council, stated that its membership now stands at 327. In his report of the past year's working, Mr. Howard showed that an extensive programme of work had been carried through, ranging from discussions with the British Standards Institution, on the standardisation of petroleum equipment and materials, to the promotion of flying visits to oil refineries and research centres, both in this country and Holland. The Council had, he said, recently published its 1949 edition of "British Petroleum Equipment," which had been received very favourably by oil industry engineers all over the world. With regard to the future of the Council's work, plans had been formulated for the organisation of inter-works visits. During the year it had been possible to interest the oil companies in forming a joint committee to study problems of corrosion. It was also hoped that the oil companies would co-operate in staging an Oil Exhibition in 1951, which would simulate conditions on site in the oilfields and refineries. The newly appointed director of the Council, Colonel A. S. Osbourne, attended the meeting, and the first director, Mr. T. L. Bonstow, is continuing with the Council as its technical adviser. Sir Donald Bailey, of Sir W. H. Bailey and Co., Ltd.; Mr. Frank Kenyon, of William Kenyon and Sons, Ltd., and Mr. J. N. McDonald, of the British Thomson-Houston Company, Ltd., were elected to the Executive Committee. Mr. J. Mair, of Glenfield and Kennedy, Ltd., was elected to the Committee, and Mr. G. H. Thorn, of Dawnays, Ltd., was re-elected honorary treasurer.

British and American Electricity Supply Comparisons

THE speed of erection of new generating plant in Britain was unfavourably compared with that in the United States by Sir John Hacking, Deputy Chairman (Operations) of the British Electricity Authority, when speaking this week at the British Electricity Summer School, Oxford. Sir John, who recently returned from a seven weeks' visit to the United States to study latest practices in the American electrical industry, said that whereas in Britain the erection of a new boiler of medium capacity normally took about eighteen months, large boilers were being erected in America in between eight and ten months. The time taken for the erection of large turbo-alternators was three months or less, compared with the usual time of about nine months in this country. In America, adequate supplies of both labour and materials were available and in no case was the installation of plant being held up due to lack of components. Welding was widely employed in the assembly of boilers and pipework, and in one or two instances where several boilers were being installed, about eighty welding machines were seen on site. In another instance, where a single large boiler was under construction, a battery of some thirty or forty welding machines was observed. The relations between various classes of men and their employers appeared to be good and there was the greatest co-operation to ensure that the work should be completed by the required date. In plant erection, as in maintenance work, two—and sometimes three-shift working was common. Sir John explained that the winter did not cause the same peak load problem in America as it did in Britain. This was not because of more plant being available to meet demand but because very little use was made of electric space heating and the tariffs of many companies were such as to discourage its development. In the majority of cases domestic and commercial buildings depended on some form of central heating either by steam, coal, oil or gas, and in consequence the electrical load on the system was less sensitive to temperature variations than in Britain. Much wider use was made of air conditioning, which was responsible for quite a substantial load during the summer months. The average American home was well equipped with electrical appliances and the load factor of the domestic supply was reasonably high. The use of water heaters and the preferential tariffs, which have been designed to encourage industrial load during the night, have resulted in a substantial increase in the night load, which was normally something like 50 per cent of the daily peak load, compared with 25 per cent in this country.

The Underground Mining Machinery Exhibition

No. I

AN exhibition of underground mining machinery was opened in London at Earls Court on Thursday, July 7th, by Lord Hyndley, the Chairman of the National Coal Board. The exhibition will be open daily from 10 a.m. to 6 p.m. until July 16th to technical, trade and other visitors particularly concerned with this branch of industry. but not to the general public. Delegates to the Fourth Empire Mining and Metallurgical Congress, now being held in London, will pay an official visit to the exhibition on Monday next, July 11th.

This exhibition has been organised by the Council of Underground Machinery Manufacturers in order to show the important new trends in underground mining which have been developed in Britain during the past few years. It contains what might well be claimed to be the most comprehensive collection of underground equipment ever brought together. The exhibits include a wide range of coal cutters, conveyors, locomotives, power loaders, drilling machines, electric and pneumatic tools, together with a variety of accessories. A large number of the machines are shown in motion and to add to the information obtainable at the stands a programme of films has been arranged to show visitors much of the plant in actual operation underground.

As might well be appreciated, most of the equipment exhibited is of specialised design and restricted application, but many of the machines will be of interest to engineers in general, and we propose to deal with some of the unusual as well as some of the representative types of plant in the articles which follow. Space does not permit us to deal in full detail with the large numbers of cutters, conveyors, small tools and equipment, &c., exhibited on the thirty or more stands, but we have endeavoured to select plant which is unusual or generally representative, whilst referring briefly to other items

Mavor and Coulson, Ltd.

A representative selection of the extensive range of underground equipment made by Mavor and Coulson, Ltd., of Bridgeton, Glasgow, to be seen on that firm's stand includes some of its latest products which are being exhibited for the first time.

Two arrangements of the Samson loader, of which one is shown in Fig. 1, are exhibited. This loader consists essentially of a crawler track carriage, projecting from the front of which is a loading ramp with two gathering arms. A hopper is formed at the back of the ramp, and extending rearwards is a jib carrying a conveyor chain arranged to remove material deposited in the hopper by the gathering arms. When the machine is in operation it is fed forwards on its tracks to force its ramp into the heap of material. The arms on the ramp gather the material and feed it rearwards into the hopper, whence the conveyor belt transfers it to the rear of the machine to fall into trucks or on to a conveyor line.

The loading capacity of these machines naturally depends on the working conditions and the material handled. Under suitable conditions it is stated to be possible to gather and load coal in an underground heading at a rate of up to 4 tons a minute.

A loader can be driven by either a 30 h.p. a.c. or d.c. motor or a compressed air turbine. The power unit is spigoted on to a cast steel transmission gearcase, in which the shafts are arranged side by side to reduce the height required. The transmission gears are controlled through multiple plate and dog clutches. In order to facilitate maintenance and servicing the top halves of the transmission shaft bearing housings are removable, so that the shafts can be lifted out complete with their bearings and gears.

The surface of the loading ramp is flat and smooth, and sunk flush in this surface are two crank discs which actuate the cast steel feeding or gathering arms. The upper end of each arm slides in a pivoted block made of "Meehanite," there being no exposed links likely to check the free flow of the material. As the arms lie close to the surface of the ramp, lumps cannot become wedged under them and the makers state that the arms work freely even when gathering finely-broken hard stone. At the rear of the ramp the receiving end of the chain conveyor is arranged well below the surface to form the hopper into which the material is swept by the arms.

The 10in wide crawler tracks through which the machine is propelled and steered are designed to provide a steady drive on the straight or around corners and on level roads or up or down steep gradients. At the lowest speed the crawlers propel the machine at a speed of 54ft per minute and at the highest speed at 155ft per minute.

Jacks which are used for raising the gathering head of the machine and raising and slewing its conveyor jib are hydraulically operated. The head can be raised 14in or lowered 6in in respect to the normal loading position. The jib end can be raised 26in above a position parallel to the floor and the jib itself can be slewed up to 45 deg. to either side of the machine. During the loading operation the head rests on the floor by its own weight and freely follows any changes in level.

All controls for the machine are grouped in a readily accessible place on one side near

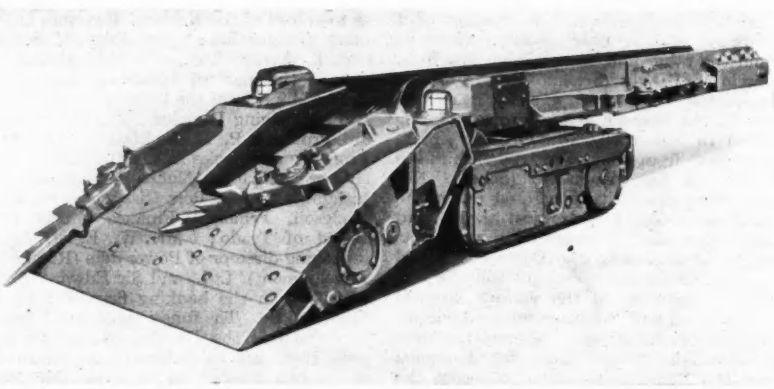


Fig. 1—"Samson" Loader—Mavor and Coulson

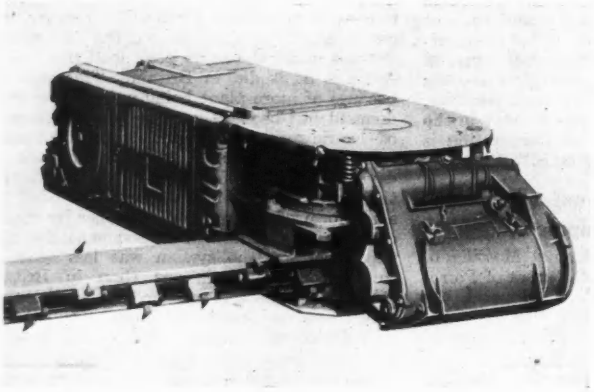


Fig. 2—19-inch Coal Cutter with Spiral Gummer—Mavor and Coulson

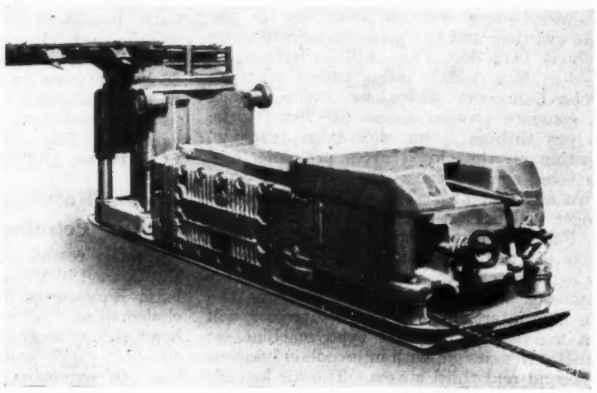


Fig. 3—15-inch Turret Head Coal Cutter—Mavor and Coulson

the front of the loader, and to facilitate working two headlights protected by heavy armour plate glass are fitted. A light at the end of the jib is arranged to provide illumination for the material being delivered from the conveyor at the rear of the machine.

The range of "Samson" coal cutters on the stand includes a new thin-seam cutter, which takes a kerf up to 6in and has an overall height of 12in; two 15in longwall machines, one 15in high, and the other fitted with a hydraulic turret with which the cutting height can be varied; an arc shearer with a jib 8ft 6in long to cut places 21ft wide; and a 19in machine fitted with one of the firm's spiral gummers and a controlled spray for wet cutting purposes.

The gummers are designed to remove some 80 per cent of the cuttings from the sprocket as they are brought out by the chain when the machine is working, to eliminate the necessity for shovelling behind a cutter as it moves along. A spiral gummer consists of a short worm driven through bevel pinions and a safety clutch from the gearhead of the machine. This worm is held in position adjacent to the driving sprocket by a combined side cover and chain fence, which is arranged to fit on either side of the machine according to the direction of travel. Gummers of this type can be made for discharging the cuttings either in the track of a machine or for placing them at the side, well clear of the working face.

When wet cutting is in progress water piped to the machine enters it through a valve at the haulage end, and passes through a two-way cock, a filter and rigid pipes to jet-boxes at the front. Nozzles in the jet-boxes are arranged to play sprays of water on to the pick-boxes of the cutter chain as they enter and leave the cut. It is pointed out by the makers that the effectiveness of the water sprays is considerably increased by the gummer and its guard-plate. These fittings enclose the cutter chain where it is out of the cut and serve to hold air-borne dust long enough for it to be wetted and laid.

A valve, which is used to control the supply of water to the sprays, is connected to the camplate control handle, which is used to adjust the speed of the machine along the coal face. By this arrangement, as cutting is stopped, the water supply is also cut off and the amount of water supplied is kept proportional to the distance cut and is almost independent of the cutting speed, which can be varied as required.

The 19in coal cutter fitted with a spiral gummer and water sprays is illustrated in Fig. 2.

The hydraulic turret fitted to the 15in longwall machine on the stand provides means of varying the cutter height from 2ft 6in to 3ft 2in from the floor to the top of the picks. In this machine (see Fig. 3) the turret which carries the cutter is supported on four piston-rods projecting up from a large ring-type piston. This piston is moved by fluid under pressure up and down an annular cylinder formed in an extension of the main gearhead casing round the sprocket driving shaft of the cutter chain. A downward extension of the turret encloses the cylinder and serves to protect the moving members from dust. The whole turret is rigidly held against side thrust during working by four guide pillars mounted on the gearhead casting.

Oil is fed to the closed-circuit hydraulic system of the turret by a plunger pump, which is driven by an extension of the pin at the small end of the haulage connecting rod. A small hand-lever-operated rotary valve used to control the movements of the turret; it automatically returns to neutral when it is released. It takes about three minutes to raise or lower the turret over its 8in of adjustment and the height of the turret can be changed during the actual cutting operation on the coal face.

A number of driving gears for belt conveyors of different capacities, lengths and gradients on view have power capacities from 10 h.p. to 200 h.p. The gears are of compact design and have large driving drums. One gearcase is cut away to show the ground gearwheels turning at crawling speed. Another driving gear is built into a loop take-up, which can quickly take up and store or let out a 60ft length of belting. The belt is passed through the take-up in either of two ways, according to the gradient, so that the tension can always be applied on the slack side of the driving gear. The sliding take-up pulley is drawn along by a rope winch, with a compensating gear for correcting its alignment. A model demonstrates a device by which the belt is made to tension itself, applying only as much tension as is necessary to carry the load on the belt at the time.

North British Locomotive Company, Ltd.

One of the two 100 h.p. diesel locomotives exhibited by the North British Locomotive Company, Ltd., of Glasgow, is shown running under its own power on a short length of track at Earls Court. This engine, built for a 3ft gauge, has a Paxman 6 RQE engine and an SLM gearbox. The other engine, for 2ft 6in gauge, has a Crossley BWL5 engine and is shown mounted on a stand running at slow speed.

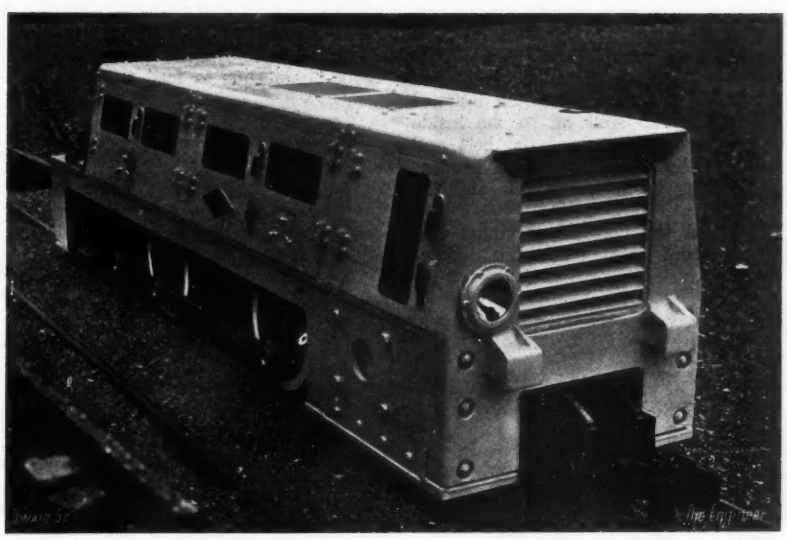


FIG. 4—100-H.P. MINE LOCOMOTIVE—NORTH BRITISH

This type of locomotive, which is illustrated in Fig. 4, was described in some detail in THE ENGINEER of August 13, 1948. It is designed for construction with a variety of transmissions, which can be fitted without necessity for major alterations. The first locomotives built had the engine drive transmitted through a rubber-bonded flexible coupling to an SLM oil-operated three-speed gearbox. Later locomotives have a Vulcan-Sinclair fluid coupling driving either a Wilson epicyclic four-speed gearbox or the SSS Powerflow three-speed gear. One locomotive will have Voith turbo-transmission.

The principal dimensions of the engines built for either 2ft 6in or 3ft rail gauge are as follows:—

Maximum length over buffer beams	15ft 1in
Maximum width	4ft 0in
Maximum height	4ft 5in
Wheelbase	4ft 7in
Diameter of wheels	2ft 0in
Minimum curve	60ft
Maximum speed	15 m.p.h.
Tractive effort at 25 per cent adhesion ...	8,400 lb

On the basis of this value of tractive effort, and assuming a rolling resistance of 14 lb per ton and 80 per cent efficiency of transmission, the locomotive will haul a train of 405 tons on the level or of 115 tons up a gradient of 1 in 50 at 3 m.p.h. We are informed that dynamometer tests have shown that the calculated figure for tractive effort can be exceeded by a comfortable margin.

British Jeffrey-Diamond, Ltd.

The display of underground plant on the stand of the British Jeffrey-Diamond, Ltd., of Wakefield, includes various types and sizes of coal cutters, belt and scraper chain conveyors, driving gear and a new power loader.

Amongst the coal cutters there is to be seen one of the company's new 12in "Ace" machines and a ranging machine fitted with a hydraulically operated turret.

An improved gummer for automatic kerf cleaning is shown on one of the large cutters arranged for undercutting. This gummer—to be seen on the machine illustrated in Fig. 5—is designed to sweep in the cuttings as they are brought out by the chain and discharge them in a neat pile at the side of the machine. When machines are fitted with this unit they leave sufficient room when working for unobstructed cogging and timbering. The gummer is a self-contained unit and can be quickly attached to or removed from a machine. It is driven through spur and bevel reduction gearing from the cutting end of the machine and its mechanism is protected against severe shocks during cutting by a shear pin housed in an extension of the bevel pin shaft. The cowl of the gummer encloses three blades mounted on a pin and so arranged that when the cowl is rotated the blades are automatically extended and retracted. When the cowl is turning each blade is extended its fullest at the point nearest the

cutter chain and serves to sweep the cuttings into the discharging chute.

The turret of the new ranging machine is operated by a hydraulic pump in the haulage end of the machine. Oil under pressure is fed to turn hydraulic jacks arranged diametrically opposite one another about the main sprocket shaft of the cutting end unit. These jacks are double-acting and serve to raise or lower the turret head carrying the jib over a distance of 9in, either whilst the machine is working or when it is stationary. The jack assembly is totally enclosed and the jib casting is formed with a large diameter turret, which acts as a central guide and resists the stresses imposed when the machine is in operation.

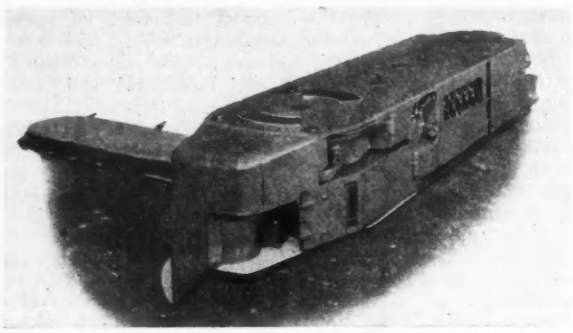


FIG. 5—"ACE" COAL CUTTER—BRITISH JEFFREY-DIAMOND

Amongst the belt conveyor equipment in this stand is to be seen a self-cleaning tail-end unit. This unit, to be seen with its inspection cover removed in Fig. 6, is used with belt conveyors which carry their load on the upper part. It has been designed to remove material spilt on to the inside surface of the lower run of the belt and return it to the upper part, and prevent it from passing between the belt and the pulley.

In operation the belt passes round and rotates a "drum" which has four double-helical blades. As the lower part of the belt moves on to the drum, it is flexed and slightly vibrated by the action of the blades. As the belt then passes to the vertical position the smalls fall off on to the blades. The blades are set at an angle and cause the smalls to gravitate to both sides of the belt and collect in the space formed by the base plate, the side frames and back cover of the tail-end unit.

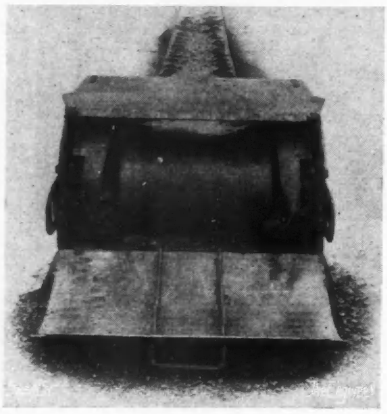


FIG. 6—SELF-CLEANING TAIL END UNIT—BRITISH JEFFREY-DIAMOND

Eight small scoops or buckets, four on each side of the drum, pick up the smalls and return them on the upper part of the belt. Each bucket is attached to a short spindle, which is pivoted on a bracket fitted to the end of the drum, the bucket projecting beyond the pitch circle of the drum and being free to pivot inwards, i.e., towards the drum. Bucket movement towards or away from the drum and belt is controlled by two hardened steel rollers on each bucket spindle, one roller being situated on each side of the pivot. As the drum rotates, carrying the bucket with it, the rollers run on tracks formed on the inner surface of a cam plate fitted to each side of the frame of the unit. The roller tracks on the cam plate are so arranged that, as the buckets move gradually inwards, they are directed vertically downwards in the lowest position so that they dig into the smalls on the belt. As their movement continues the buckets swing gradually inwards to discharge their loads on to the belt, after which they are withdrawn sharply so as to avoid striking the belt. The sudden movement also assists in clearing the buckets of their contents.

Particular interest attaches to the conveyor loader illustrated in Fig. 7. This machine consists of a gathering head mounted on an extendible boom along which a conveyor chain runs to feed the coal back on to a discharge conveyor. It is designed to gather and discharge up to 1½ tons of coal a minute on to the outgoing conveyor line, and, having an overall height of only 2ft, can be used on seams as low as 3ft. The loader is mounted on four pneumatic-tyred wheels on which it can be moved under its own power between working sites.

A single 18 h.p. electric motor drives the coal-gathering head, the discharging conveyor and a high-capacity medium-pressure pump which supplies fluid to the hydraulic motors and rams used for a number of operations on the machine. Push buttons on the panel start and stop the main motor drive. Finger-tip levers control the supply of oil to the hydraulic motors and rams which are used for driving, steering, extending and retracting the gathering head, &c. A separate small hydraulic pump at the gathering head is operated from the control platform to raise and lower the head.

The machine is moved at a speed of 75ft per minute by hydraulic motors connected through roller chains to both front wheels, and steering is effected by means of hydraulic cylinders on the rear wheel mountings. When coal has been shot down for removal the loader is driven in the room or entry and stopped with its gathering head at the coal line, and its discharge end overlapping the outgoing conveyor line. In this position a hinged hydraulic roof jack on the right-hand side at the rear of the loader is swung into a vertical alignment. On the upper and lower jacking pillars then being extended it is wedged between the floor and the roof and forms a pivoting point on which the loader can be swung in a horizontal arc. The retractable rear wheels of the loader are then raised clear of the floor by the hydraulic jacks and the front wheels are turned inwards. In this arrangement the machine is supported in front on two wheels, and can pivot on the third point of support formed by the roof jack at the rear, so that the gathering head can be traversed in an arc across the face of the pile of coal. By means of a hydraulic motor the gathering head is then dropped at one side of the front of the coal line.

The gathering head, which is of heavy, rigid construction, has a base plate designed to slide freely over the floor as the loading boom is extended to drive the head into the loose coal. On each side of the head is a gatherer, which consists of an endless chain, from which projects a series of drop-forged flights. As the head is driven into the coal the gatherer chains are mechanically driven through a hydraulically-operated friction disc clutch, and the moving flights serve to loosen and feed the coal back on to the boom conveyor chain.

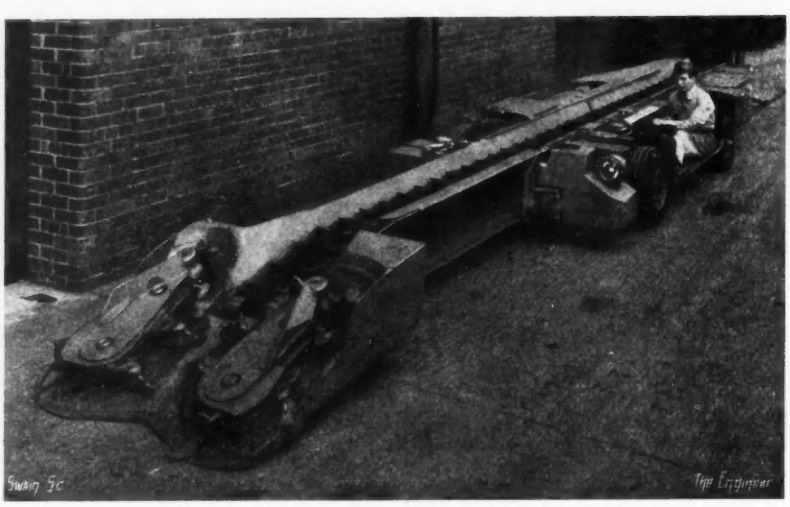


FIG. 7—CONVEYOR LOADER—BRITISH JEFFREY-DIAMOND

When the boom has been extended forwards for its full length of 12ft and all the coal in its path has been removed, it is retracted into the machine. The driving gear of the front wheels is then engaged to traverse the head of the loader through the necessary arc before the boom is again extended to gather the coal in the next position. This cycle of operations is repeated

until the pile coal has been removed. The makers state that the loader is able to gather the loose coal along the face of a 35ft room from one working position. It will be appreciated that as the machine pivots from a fixed point at the rear when in operation its discharge point remains unchanged and the operator is able to concentrate his full attention on the gathering head.

Cowlishaw, Walker and Co., Ltd.

In connection with the range of coal-face conveying equipment exhibited by Cowlishaw, Walker and Co., Ltd., of Biddulph, Stoke-on-Trent, that company has sent us some interesting notes on the development of its double-drive chain conveyor. One of these conveyors, complete with remote control switchgear, is being demonstrated at Earls Court.

It was in 1932 that the firm, seeing the latent possibilities of the chain conveyor, introduced a new form designed expressly for the British longwall system of mining. It employed a light, high-tensile steel, short-pitch double-strand chain in place of the single-strand long-pitch malleable iron chain of the original "Blackett" conveyor, and permitted the use of higher speeds, which brought the capacity of the chain conveyor into line with modern requirements. The double-strand chain was found to be easier to handle than the single-strand type, a fact which appealed to workers on the coal face.

Scraper chain conveyors have, during the past few years, been used in lengths exceeding 200 yards with the gradient in favour. Until quite recently, however, these conveyors were limited to approximately 100 yards in length on the level, due to the tendency for a freely supported scraper chain to climb in the pans on longer conveyors.

It was considered that if chain conveyors could be driven from both ends, the tension in the carrying portion of the chain would be reduced; the chain would lie in the pans better and greater lengths would be possible in one unit under level conditions. The problem involved was the synchronisation of the two driving motors. When details of German wartime practice became available it was learnt that the Panzer Förderer conveyor was driven in this way, employing a rather complicated system in order to avoid synchronisation troubles. The German designers used either an a.c. motor at one end and a compressed air turbine at the other or an a.c. motor at each end fitted with either a hydraulic or an epicyclic gear coupling. As with this design the scraper chain was positively held down in guides for the full length of the conveyor, the power required was very large, being about 100/200 h.p.

It was appreciated that the German conveyor was much too cumbersome, complicated and wasteful of power for longwall application in this country and investigations were undertaken employing two simple driving units with an open type of longwall chain conveyor having a freely supported unguided chain on lengths of some 150 yards on the level. Then, in the middle of 1947, the agent of a colliery in Cumberland, Mr. M. B. Miller, of Naworth, wished to work a 120 yards face in a thin seam on level and all he had available were Cowlishaw, Walker 12in longwall chain conveyor sections and a.c. motor-driven 5 h.p. worm type drive units. As the 5 h.p. units were only recommended for a length of 60 yards on the level, Mr. Miller decided to put one at each end of the required 120 yards long conveyor and switch the motors on and off simultaneously. The experiment proved successful; the two a.c. motors synchronised perfectly, and the unit worked without trouble. It was found that no synchronisation problem arose, as the small amount of slackness in the scraper chain provided the necessary flexibility for the two motors to pull themselves into step in a very short time.

As a result of the successful experiment, further tests were made by the company at its North Staffordshire works. A chain conveyor 180 yards long was laid on very undulating ground, rising approximately 1 in 30 against the load, with a 15 h.p. electric a.c. driving motor at each end. The two motors had identical characteristic curves. The experiments showed that the scraper chain kept down in the pans very well and apart from a little hunting until the motors had adjusted themselves, each motor almost exactly shared the load with the other under conditions of both light and heavy loading.

The effect was then tried of placing a 15 h.p. motor on the drive at the head of the conveyor and a 10 h.p. motor on the tail drive; although of different powers, the two motors had similar characteristic curves. It was found that each motor shared the load in proportion to its rated capacity, i.e., the head motor exerted 1·5 times the effort of the tail motor, both for light and heavy loads.

After this the conveyor was tried with a 15 h.p. compressed air turbine at each end, then it was tried with a 15 h.p. a.c. motor at the head end and a 15 h.p. compressed air turbine at the tail end. In every case both starting and running were found to be smooth and easy and synchronisation was perfect.

The designers considered that the success of the experiments was due to the basic speed/torque characteristics of a squirrel-cage induction motor. If one motor was called upon to exert more torque its speed dropped and through the medium of the scraper chain the speed of the other motor was decreased, thereby automatically making it increase its torque as well.

A number of these units, which have been installed at collieries both at home and abroad, are stated to have given satisfactory results.

The underground application of new arrangements of electrical equipment requires special consideration so as to comply with statutory regulations. For this reason, a simple circuit for the simultaneous remote control of two electric motors on one conveyor has been worked out by A. Reyrolle and Co., Ltd.

Victor Products (Wallsend), Ltd.

Numerous examples of the company's compressed air-operated and electric drills, drill rods, flameproof lighting fittings, &c., are shown on the stand taken by Victor Products (Wallsend), Ltd., of Wallsend-on-Tyne.

The electrical equipment displayed includes the low-height flameproof gate-end box of the transformer type, shown in Fig. 8. This standard unit provides means of control by tappings for two electric drills at 125V from any incoming 50-cycle three-phase supply up to 625V. It has a strong flameproof steel case with an incoming multi-way box and outgoing 30-A, four-pin detachable plugs and sockets. A replaceable unit three-pole quick make-and-break isolating switch in the box is interlocked with the door. The transformer and the control mechanism is built as a unit on a single mounting, which can be easily withdrawn from the case. A separate winding on the main transformer provides a single-phase 24-V pilot circuit, there being two-pole reversible fuse protection and intrinsically

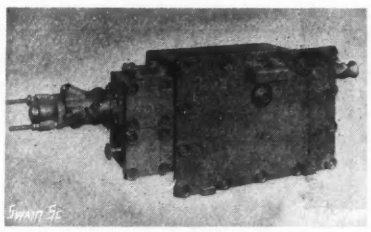


FIG. 8—50-CYCLE GATE-END BOX—VICTOR

safe condenser control. Unit-type replaceable four-pole contactors provide effective overload protection for drill circuits. A visual external indicator shows when the isolating switch of the box is "on" or "off" or if an earth fault exists. A push button is provided to reset on overload and leakage can be reset by means of a key.

The firm is also showing a small 50-cycle gate-end box for controlling one electric drill of the pilot controlled type, and a small transformer control unit, for use in connection with incoming 50-cycle three-phase supplies up to 625V.

A powerful coal or stone drill which weighs 37 lb and is designed for 50-cycle operation, is shown in Fig. 9. This machine has

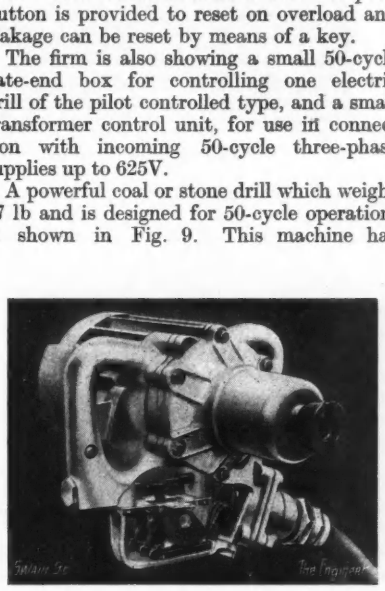


FIG. 9—ELECTRIC DRILL—VICTOR

hardened and ground epicyclic gears, which are built as a unit and can be quickly stripped and reassembled for maintenance purposes. It has a three-pole, trigger-operated switch, which is clearly shown in the cut-away portion of the illustration. This switch is arranged behind its own cover and can be removed as a unit for quick replacement. A 150-cycle coal drill displayed is designed to work from a gate-end box arranged to give 150 cycles from a 50-cycle circuit. This drill incorporates a motor which has a speed of 9000 r.p.m. and drives the chuck through epicyclic gears at 530 r.p.m.

Hunslet Engine Company, Ltd.

The four types of flameproof diesel-engined mine locomotives made by the Hunslet Engine Company, Ltd., of Jack Lane, Leeds, are shown on that company's stand. These engines consist of a 24 b.h.p. "pit pony" type intended for use on the lightest tracks and narrowest gauges; a 65 b.h.p. general purpose locomotive with a top speed of 9 m.p.h.; a similar locomotive of 70 b.h.p., with a top speed of 14 or 15 m.p.h.; and a 100 h.p. locomotive for

coal haulage or man-riding at speeds up to 15 m.p.h.

The so-called "pit pony" locomotive is of very simple construction, being driven by a two-cylinder oil engine and having a single-step gearbox which gives a top speed of 6 m.p.h. forwards and in reverse. It has a riveted steel plate frame and the two axles of its 16in diameter wheels are chain-driven from the output shaft of the gearbox. The wheelbase is 24½in and enables an 18in gauge locomotive travelling alone to negotiate curves as sharp as 16ft radius.

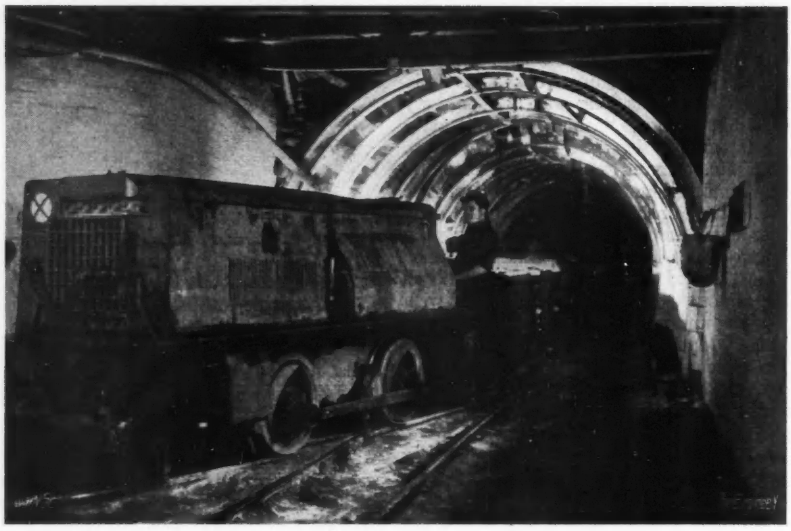


FIG. 10—70 H.P. FLAMEPROOF MINE LOCOMOTIVE—HUNSLET

The company's 65 b.h.p. four-wheeled locomotive was introduced as a general-purpose engine for both coal haulage and man-riding work where physical and traffic conditions restrict maximum speeds 9 or 10 m.p.h. It embodies a design feature of the maker's in that it is built up on a one-piece cast framework of high duty iron. This form of construction is claimed not only to give a high degree of rigidity and facilitate erection, but also to enable all the necessary adhesive weight to be provided within severe restrictions of length, width and height without making the locomotive cumbersome or rendering vital parts inaccessible. In designing the locomotive weight up to the limit of 5 tons an axle was needed to provide adequate braking weight for trains of unbraked tubs, for one of the leading considerations was the provision of a powerful locomotive which could run over existing tracks and gradients and pull existing tubs without calling for expensive modifications in the mines concerned.

To get the highest possible traffic performance in coal hauling and man-riding over a wide range of physical conditions the 70 h.p. general-purpose locomotive, illustrated at work in Fig. 10, has been fitted with a four-speed gearbox and has a top speed of 14½ m.p.h. With this locomotive, in order to spread a large construction programme over a wider section of industry, a welded and riveted form of frame structure was adopted, and an alternative type of power unit was adopted. All locomotives of this design made by the firm are built with Westinghouse air brakes and, where needed, train braking equipment can be fitted. The brake apparatus is built as a special sub-assembly, which, when fitted on the locomotive, only needs two pipe connections to be made.

Largest of all the Hunslet range of mine locomotives is the six-wheeled, 100 b.h.p. engine, which was described in some detail in THE ENGINEER of May 7, 1948. This locomotive is driven by a six-cylinder Gardner oil engine through a four-speed gearbox. It is capable of hauling loads up to 375 tons at 4 m.p.h. on the level under suitable conditions.

For the design and manufacture of its mine locomotives this company has extensively practised standardisation of units. The wheels, tyres, axleboxes, brake blocks and springs are the same in the 65, 70 and 100 b.h.p. locomotives. The 65 and 70 b.h.p. models have the same exhaust gas conditioners, flame arresters, radiator, air compressor, and air starting motor; and the 70 and 100 b.h.p. types have the same driving controls.

HARDYPICK, LTD.

A new equipment for drilling deep slots at roof level for the insertion of corrugated support bars, designed to prevent breaks at the back of the cut made by a coal-cutting machine, is exhibited by Hardypick, Ltd., of Sheffield. This machine drills slots beyond the depth cut by the cutter jib, and the bars inserted into them are supported at their inner ends in the coal face and at their outermost ends by the usual face props. The support given by the bars prevents the roof breaks which frequently occur at the back of the cut.

Experiments with the first bank bar slotting machine were made in 1936 and the equipment used was an adaptation of the firm's column-mounted electric stone boring drill. In this machine the single-drill chuck was replaced by a gearbox having three chucks arranged in a horizontal line on centres approximately 1¾in apart. The drill head complete with the motor was mounted in a cradle sliding on a steel rack bar and operated by means of a pinion and shaft rotated by a ratchet lever. With it the first operation in making a slot was to drill a 2⅜in diameter hole at roof level with a drill rod inserted into the centre chuck. This hole was drilled to a depth of 6ft 6in. The next operation formed the slot by means of a cutter rod, which consisted of three ordinary drill rods linked together in line and provided at the driving end with lugs to engage in the three chucks. At the working end was fitted a small bevel gearbox, driven from the centre rod, and on this box two drum type cutters were mounted. These cutters cut into the sides of the pre-formed 2⅜in diameter hole, while the two outside rods of the set acted as conveyors to scavenge the cuttings from the hole. The slot thus formed was approximately 5½in by 2¼in, which was sufficient to allow free access to the usual roof strap. The cutters were found to work very well, but as they rotated in opposite directions a torque was developed by the bevel gearbox and as slotting proceeded a twist developed, which proved difficult to correct. Depending on the rate of feed this twist occasionally amounted to approximately 15 deg., which, naturally, obstructed the entry of the bar.

After extensive trials it was decided to abandon this type of cutter and substitute a set of three drill rods, tied together in line as before, but having at the cutting end three conventional drilling bits with the centre one acting as pilot ahead of the outside bits, thus allowing sufficient clearance for their operation. The whole set was prevented from twisting by enclosing the centre rod in a tube rigidly fixed to a cross tie at the drilling end and to the bore head at the outer end. With this arrangement three holes were drilled at

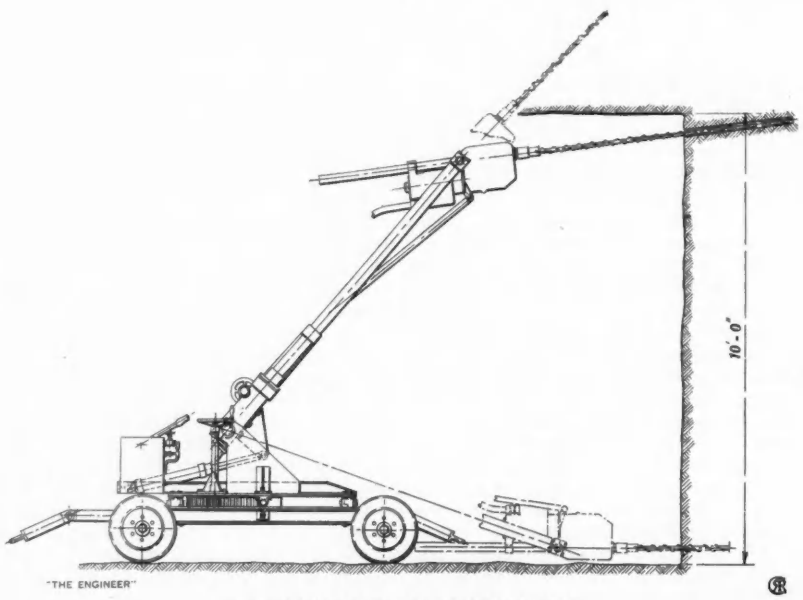


FIG. 11—HEADING DRILL—HARDYPICK

the same time on centres which caused them to break through, thus forming a slot or channel which was suitable for the entry of the bar.

This method proved to be entirely successful, and in tests fore-poling proceeded during every filling shift on a 40-yard length of face, with bars being put in to the full depth of 6ft 6in at a distance of 4ft apart. A great improvement in roof conditions was shown after the bars had been inserted for only two or three shifts, and this resulted in the company deciding to proceed with the design of a machine capable of following a loader down the whole length of the face, preparing the roof for the following cutting shift. The arrangement of the bars and the shape of the slot formed by the machine is shown in Fig. 12.

Having developed a proved principle of slot forming, it was necessary to consider how the operations could be speeded up; but, unfortunately, all development work was stopped by the outbreak of hostilities. Now a new and more powerful machine has been designed and built, which has a 6 h.p. motor instead of 1½ h.p., as on the experimental machine, and drilling speeds of 4ft to 6ft per minute are anticipated.

In the new equipment the drill head is mounted on a swinging and tilting platform, which can be raised or lowered to suit the position of the bank bar. Vertical range on the lowest machine is 2ft 6in to 3ft 6in, and other heights are obtained by the use of a longer central column. When drilling, the machine is held in position by means of two 6-ton hydraulic jacks acting between roof and floor. These jacks are operated by a ram pump driven by the motor. The machine is mounted on a crawler track, also driven by the motor.

With the increased need for intensive heading drivage, a heavy-duty electric rotary drilling machine on show is designed to drill the full round of holes in a heading and then to be quickly flitted on self-propelled tracks or rubber-mounted wheels to the next drilling site.

The drilling machine itself can be worked either dry or with water injection and is driven by an integrally mounted 5 h.p. medium-voltage motor. The drill rod feed and retraction is automatically operated by a hand lever and retraction is effected while the drill rod is still rotating in the same direction as when drilling, thus ensuring complete scavenging of the finished hole.

The machine (see Fig. 11) is mounted in trunnions at the end of a tubular jib and has a controlled movement of 70 deg. about the trunnions. The jib itself is mounted in trunnions carried on a fabricated steel mounting and is actuated by hydraulic jacks, which provide elevation movement from floor level to approximately 10ft upwards. The mounting base is built on a turntable carried on rollers and a centre spigot bearing. It is provided with rack and pinion control to give azimuth movement of the whole drill mounting within limits of about 80 deg.

The tubular jib drill support can be rotated about its centre and the combination of the four movements, all easily controlled by the driver from his seat upon the mounting, will allow of a hole being quickly positioned at any practicable angle and place from 3in from and parallel to floor or roof and all intermediate positions.

The drill carriage is of fabricated steel and, if wheel mounted, is provided with brakes on all wheels. The tracked machine carriage is equipped with separate clutches to each track and has a maximum travelling speed of some 1¼ m.p.h.

It is not necessary to use chocks or roof jacks, for the machine when at a standstill is designed to withstand the thrust of the drill rod even at high-level boring.

Consolidated Pneumatic Tool Company, Ltd.

The pneumatic and electric tools and selection of other mining accessories and equipment on the stand of the Consolidated Pneumatic Tool Company, Ltd., 232, Dawes Road, London, S.W.6, include a useful diamond core drill for short-hole prospecting underground, wall sampling, &c.

This core drill can be mounted on any standard rock drill saddle and worked in any position from a column, arm or cross bar. It is driven by a high-torque rotary pneumatic motor and has sufficient power to drill holes 1½in diameter up to depths of 500ft. Cores ⅞in diameter are taken with the drill. A stepless range of drill bit speeds from 0 to 1500 r.p.m. is available, and the machine incorporates a screw feed of sufficient length to give a run of 2ft. Feed is transmitted through a self-contained gearbox, there being four feed rates, any of which can be engaged as required whilst the drill is running.

The whole of the drill mechanism is enclosed within a dustproof, oil-tight case. All the shafts run in ball bearings and the rotating parts are carefully balanced to eliminate vibration and promote smooth running at high speeds.

When the machine is in operation water is pumped down through tubular extension rods to the double-tube core barrel of the drill, the arrangement of which can be

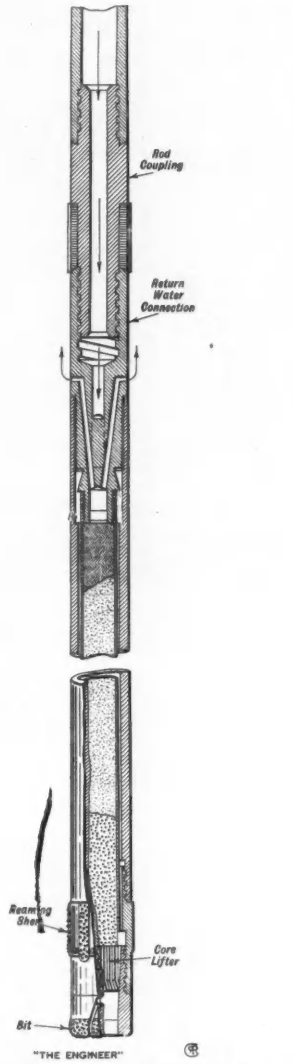


FIG. 14—DIAMOND CORE DRILL BARREL—CONSOLIDATED PNEUMATIC

seen in the drawing reproduced in Fig. 14. This core barrel, as its name implies, has an inner and an outer tube and the circulating water is fed in the space between these tubes

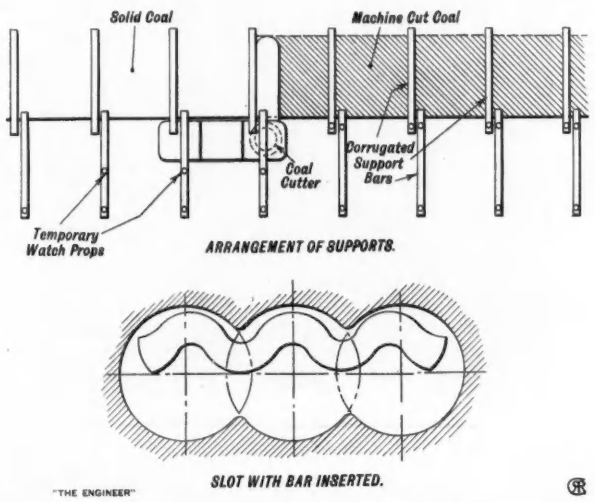


FIG. 12—BAR SLOTTING—HARDYPICK

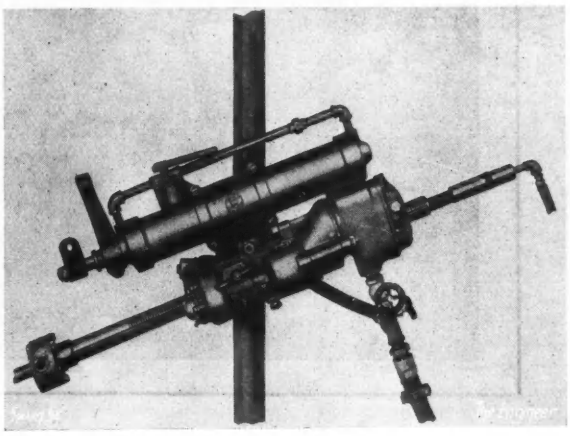


FIG. 13—DIAMOND CORE DRILL—CONSOLIDATED PNEUMATIC

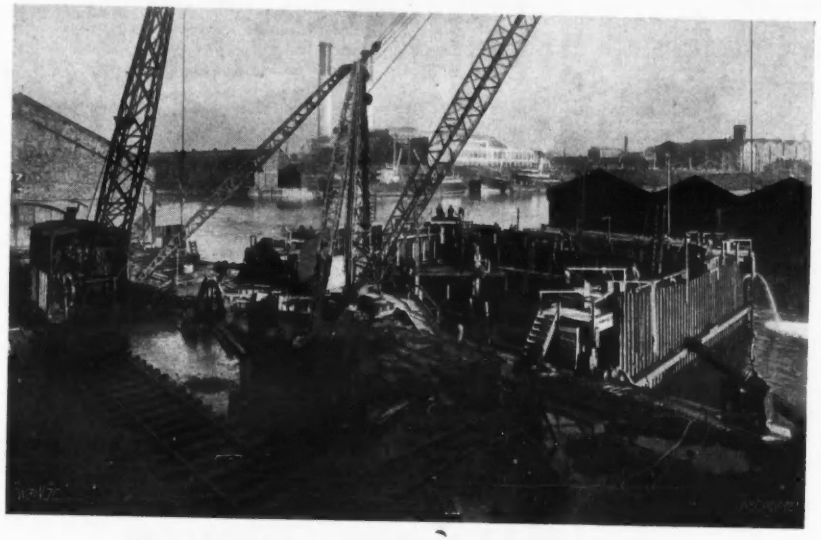


FIG. 8—COFFERDAM AT VICTORIA DOCK—TRAFALGAR PASSAGE

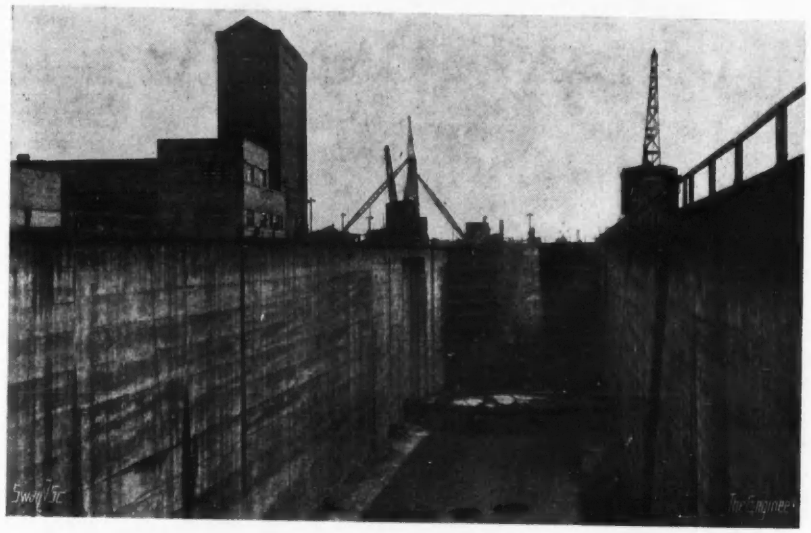


FIG. 9—OUTER END OF LOCK—WATERLOO RIVER ENTRANCE

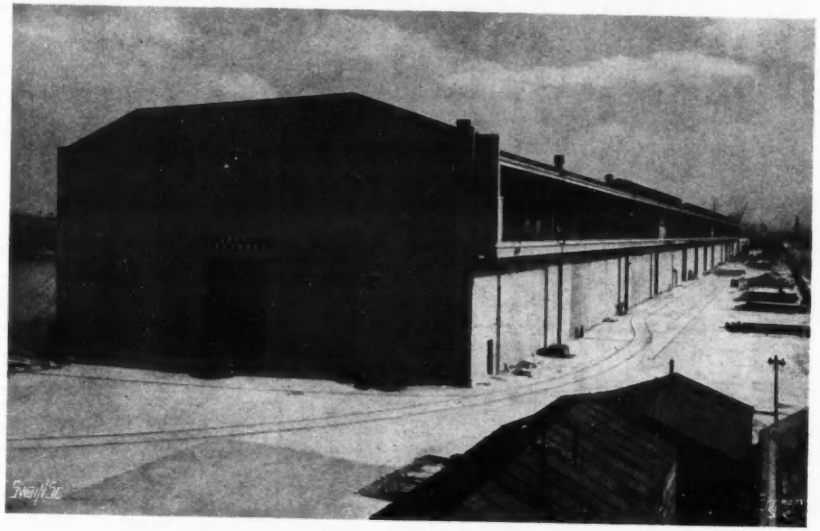


FIG. 10—TRANSIT SHED—ALEXANDRA DOCK

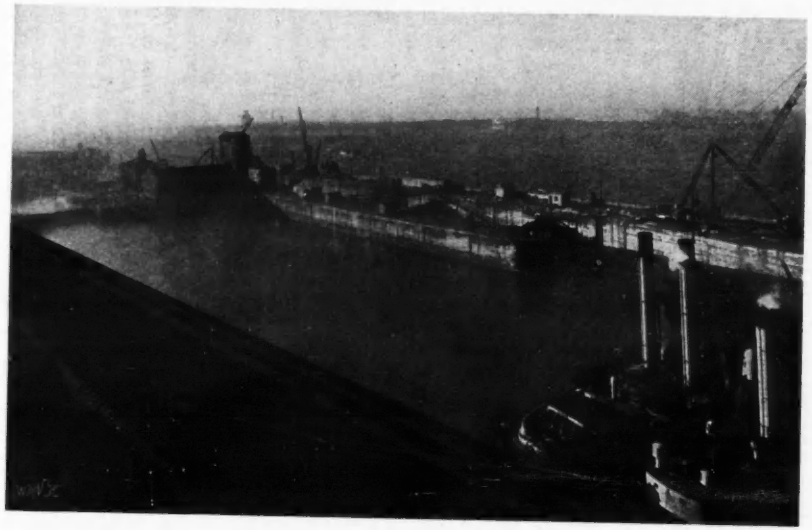


FIG. 11—COMPLETED WATERLOO RIVER ENTRANCE

directly to the bit. This design was developed to eliminate the effect of downwards water pressure on the core and to reduce the washing action, thereby increasing core recovery.

On the core barrel above the bit is a reaming shell set with diamonds, and this shell, in addition to assisting the maintenance of alignment, keeps the hole to size. A second casing tube is inserted round the drill rods as the hole progresses, and the return flow of water from the drill enters the annular space between the outer and inner tubes through holes in the drill coupling piece. This water rises between the tubes and flows out at the top of the hole, where it is directed into a settling tank. The cuttings suspended in the water are deposited in the tank and the water is drawn off for recirculation in the drill.

If required, the drill can be fitted with a rod puller, as shown in the illustration, Fig. 19. This rod puller is mounted on the bracket of the drill. When it is required the unit is simply unlocked by the loosening of a single nut and swung round to bring the puller into position. It is provided with a guide arm to ensure rod alignment and to prevent bending, and is designed to handle 400ft of rods in vertical holes with a working pressure of 80 lb per square inch.

(To be continued)

Work of the Mersey Docks and Harbour Board

No. II—(*Continued from page 4, July 1st*)

Repairs to Dockside Sheds

As might be expected, war damage to dockside sheds and warehouses was fairly extensive, and the Board's programme of reconstruction includes about £1½ million worth of work on these facilities, most most of which has already been carried out. The two largest items of reconstruction were the rebuilding of a portion of the treble-storey reinforced concrete shed on the south side of Gladstone Branch Dock No. 1, and the construction of a large shed on the west side of Alexandra dock. The first of these items, which was let to contract, owing to the large amount of work being undertaken by the Board at the time, was described in The Engineer of January 21, 1949.

The second item, the new transit shed on the west quay of Alexandra dock, is a brick walls and roofed with protected metal sheeting. The floors were laid with concrete, mass concrete being used on the ground floor and reinforced concrete on the first floor.

The column foundations, except at the roadside and centre columns of the single-storey shed, were supported by reinforced concrete octagonal piles, 45ft long, each pile being designed to carry a safe load of 80 tons. These piles were driven using a 7B semi-automatic steam hammer. To avoid damage to a live sewer passing under the north end of the shed those foundations in the immediate vicinity of the sewer were supported by bored vibrationless piles.

The staff of the Board's Engineer were responsible for the design of the shed and contingent works, and the execution of the whole

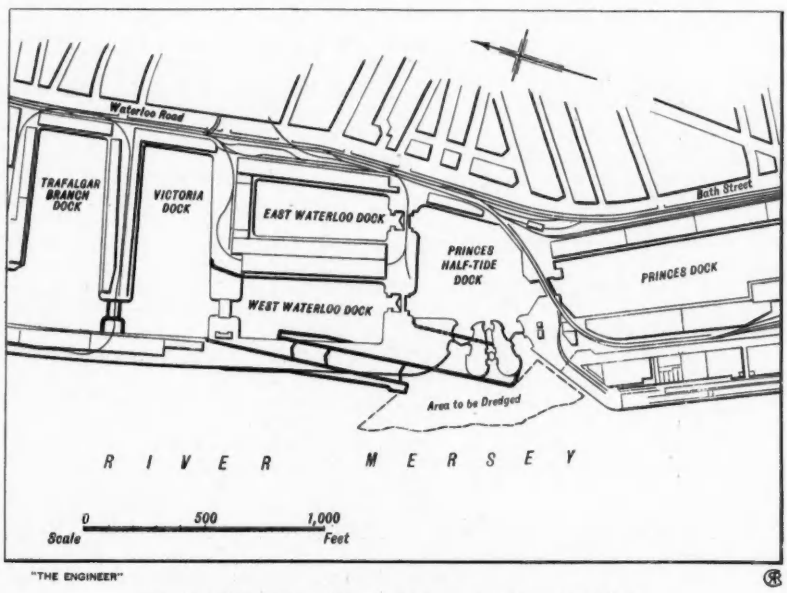


FIG. 12—WATERLOO RIVER ENTRANCE—PLAN OF WORK

structure 1597ft long by 110ft wide, subdivided into three double and two single-storey sections. It is set back from the quay wall a distance of 20ft 6in to give ample trucking space, and provision is made for fifteen semi-portal cranes on the quayside to facilitate the loading and unloading of ships' cargoes. Two railway tracks are laid on the roadside of the shed and these will be served by twelve semi-portal travelling transporter cranes. The structure is of steel with of the site work has been carried out by them, using direct labour, with the exception of the fabrication and erection of the steelwork, which was allocated to Sir William Arrol and Co., Ltd., of Glasgow. The work is to cost about £600,000 and is at present complete except for the installation of the cranes. A recent photograph of the shed is shown in Fig. 10; this view was taken from the north end and shows the rail beam for the semi-portal transporter cranes.

Other work in the reconstruction programme includes the construction of two single-storey sheds which are being built between Branch Docks Nos. 2 and 3 of the Canada dock. These sheds are designed with steel columns and trusses and brick panelling, and they will each cost about £150,000. Various other reconstruction work of a similar nature is in progress or has been completed in different parts of the Dock Estate.

The Waterloo River Entrance

Before the completion of the Waterloo River Entrance, entry to the Prince's half-tide dock and the adjacent docks had been through the Prince's River Entrances, which

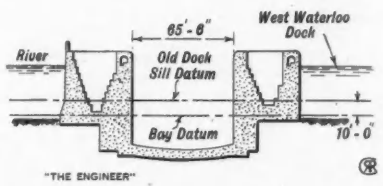


FIG. 13—CROSS SECTION OF NEW LOCK

were only available for traffic for about two hours at high water. The new lock was designed to provide access for vessels at all states of the tide, and an outline of the new work required to achieve this aim is shown superimposed upon the old configuration in Fig. 12.

The British and Irish Steam Packet Company, Ltd., and the Belfast Steamship Company, Ltd., have berths in the Princes Dock, and maintain daily passenger and freight services to Dublin and Belfast respectively. The new entrance, together with the adequate passenger facilities which are provided, will enable the vessels of these companies to sail direct from the dock, thus considerably reducing the time spent in port. It is understood that the services can then be maintained by two vessels instead of three.

Work on the new scheme was commenced in 1937, but owing to increasing difficulties created by the outbreak of the war it was discontinued in April, 1942, in order to concentrate on other work considered to be of greater national importance. The works were reopened in December, 1945, and are now complete except for a small amount of dredging.

The new lock is 450ft long between inner and outer gates, 65ft 6in wide and 58ft 6in deep from coping to sill. It is provided with an intermediate pair of gates which subdivide it into two compartments, 135ft and 315ft long respectively, for the use of smaller vessels. A cross section of the lock is shown in Fig. 13.

The whole structure was founded upon sandstone rock, and the invert of the lock was formed as a shallow inverted arch, which provides a more economical design than the more conventional flat invert. Walls and inverts throughout were constructed of mass concrete, but granite was utilised for all wearing surfaces, comprising sill facings, hollow and square quoins, copings and sluice facings. Pre-cast units were used in some cases to form the culverts.

The eastern wall of the lock has been extended so that only the south entrance of the old Princes River Entrances now remains in use, and the length of wall thus provided forms a useful berth for vessels waiting to use the lock. The provision of a suitable turning basin at the inner end of the lock necessitated the removal of the old Victoria–West Waterloo Passage, and the transfer of the Scherzer-type rolling lift bridge from

this passage to a new location which was prepared between the Trafalgar and Victoria docks by narrowing the existing water space.

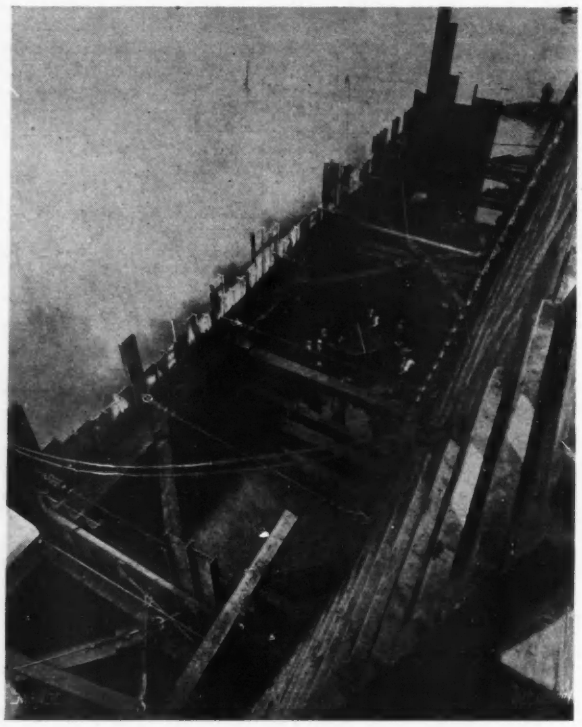


FIG. 14—HALF-TIDE COFFERDAM UNDER CONSTRUCTION

During the period of construction it was necessary to maintain access through the existing entrances with the minimum of interference to traffic. It was therefore not considered feasible to enclose the whole of the site, and the greater part of the work in the river and docks was built sectionally, under the cover of half-tide and full-tide steel-sheeted cofferdams. In all, about forty-five dams were constructed with an aggregate facing length of approximately 2500 lineal feet. The first large dam which was built was situated between the Trafalgar and Victoria docks, and the new foundations for the rolling lift bridge were constructed inside it. This dam, which is a full-tide one, is illustrated in Fig. 8. The construction of one of the half-tide dams in the River Mersey is shown in progress in Fig. 14.

In general, six or seven frames of timbering were fixed in these dams. The lowest two or three frames in the cofferdams inside the dock were fixed by divers, and the remaining frames were fixed at neap tides, the water level inside the dam being lowered as successive frames were fixed. This procedure was possible since the West Waterloo Dock is a levelling or non-impounded dock, and is levelled through with the river at each high water. Thus the water level in the dock is nearly 10ft lower than the level in the northern pump-impounded docks at neap tides.

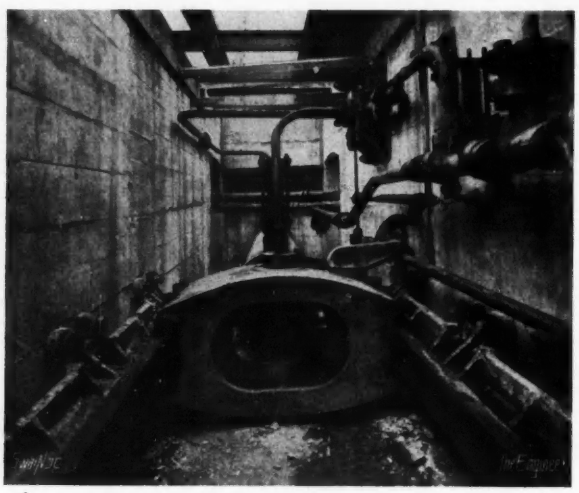


FIG. 16—HYDRAULIC GATE MACHINE

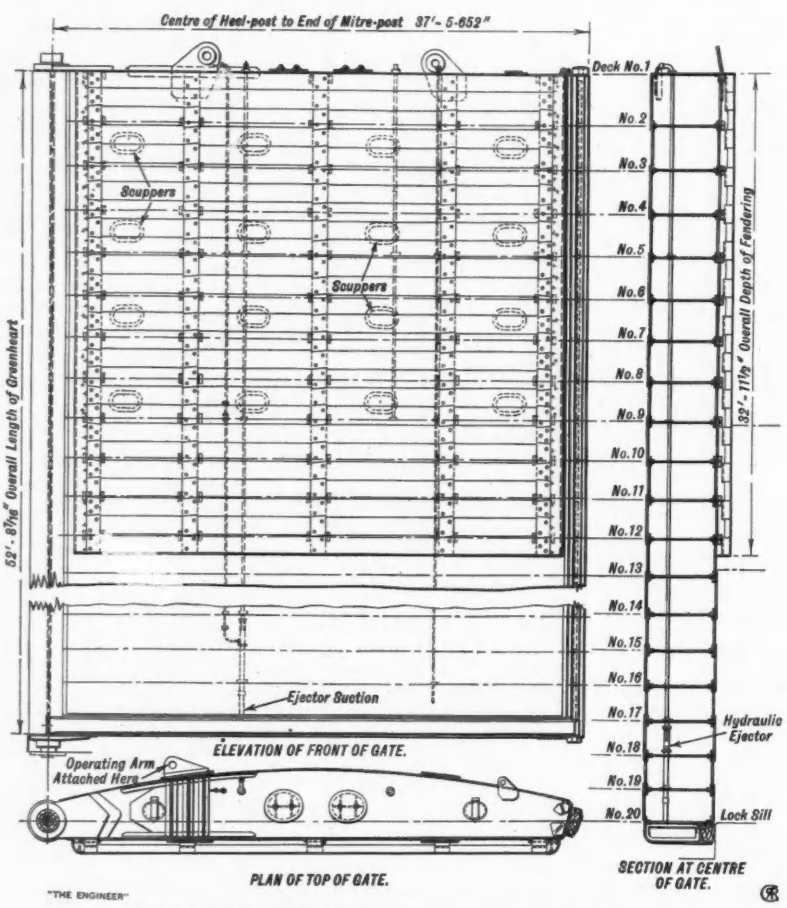


FIG. 15—GENERAL ARRANGEMENT OF DOCK GATE LEAF

The removal of the bridge was carried out in collaboration with Sir William Arrol and Co., Ltd. The bridge was lightened of ballast and then slid forward on to two lifting barges, where it was raised and floated 500ft to its new position and jacked back on to prepared foundations. Finally, the machinery and housing were transferred across by floating crane.

The tongues of the old Victoria–West Waterloo passage were then removed to dock water level by hand excavation, and the walls below this level were drilled and broken down by blasting, the spoil being removed by bucket dredger. The progress of the drilling work was facilitated by the construction of a gantry spanning the passage.

The walls of the new work were next constructed in the various cofferdams and trenches adjacent to the new lock, and then the central dumpling was removed and the invert concreted to a uniform thickness of 5ft. The existing sandstone masonry wall on the west side of the Waterloo Dock was faced with concrete to bring it to the level and line required for the new arrangement, and a culvert lined with blue brick was incorporated in the construction of the invert in order to carry hydraulic pressure and return water pipes, electric cables and fresh water pipes under the lock.

It was possible to construct the greater part of the new inside wall on the west side of the lock in trench excavation behind the existing sea wall. This work was commenced at the north end. When the excavation had reached a point approximately opposite the inner gates of the new lock, the section of trench under construction was flooded by a sudden influx of water. It was subsequently discovered that the

footings of the old river wall were in a bad condition and seepage and scour under the wall had been responsible for this occurrence. Therefore it was decided to repair the river wall by constructing a new facing wall for a length of about 350ft north of the inner gates of the new lock. The half-tide dam shown in Fig. 15 was one of the dams constructed for this purpose.

The illustration of the lock shown in Fig. 9 is a view towards the outer end and shows the outer gate sill and old river wall partly cut away. The temporary full-tide closing dam in the river which butts on to the old river wall is shown, and the buildings seen on the lock wall on the left are the dock master's offices and the tower housing the hydraulic accumulator.

Lock Gates and Machinery

The three pairs of gates in the central river entrance lock were constructed and placed in position by Sir William Arrol and Co., Ltd. They are steel gates, each leaf being fully suspended and weighing 180 tons. They are subdivided by twenty decks and three bulkheads, the ninth deck being watertight with the balance chamber above it and the buoyancy chamber below. The heel post, mitre post and clapping sill timber are of greenheart. A hydraulic ejector is provided for dewatering the lower chamber. A sketch of a single leaf is shown in Fig. 15.

Each gate is actuated by a hydraulically operated ram through a connecting-rod to the head of the gate, both opening and closing being thereby carried out by the one set of machinery. A view of the ram and crosshead of the hydraulic gate machine is given in Fig. 16; the operating arm is not in position in this illustration. An alternative arrangement for emergency operation is also installed, there being a hydraulic capstan and various steel wires and tackle provided for this purpose.

In order to ensure that vessels using the lock are worked through quickly, large section levelling culverts, incorporated in the walls, have been provided at each end of each compartment. The culverts are 5ft wide by 6ft 6in deep, and are controlled by hydraulically operated sluices, each sluice being duplicated by a hand sluice provided in case of breakdown. This machinery was constructed and fitted by Glenfield and Kennedy, Ltd., of Kilmarnock. An electrically operated footbridge is provided above the middle gates to give access between the seast and west walls of the lock. This bridge was designed and erected by Sir William Arrol and Co., Ltd.

The centre pair of gates were the first ones to be installed in the lock, and were placed in position with the aid of the 200-ton floating crane "Mammoth." These gates were fitted before the lock was completed, and the crane was positioned in the River Mersey adjacent to the gate recesses. The west leaf was placed directly into position and the east leaf was placed on to sliding ways and jacked into position. The gates were constructed in Birkenhead, and transported across by the "Mammoth." The first leaf was uprighted in the Birkenhead Docks, a direct pull from the crane being used to place it in the upright position.

This method was considered to be unsatisfactory for the remaining leaves, so the second leaf of the centre gates was uprighted in the Gladstone Dock, the only one deep enough for this purpose. This uprighting was carried out by the procedure described below, except that no cathead was used. Each leaf of the remaining gates was towed through the docks to the inner compartment of the new lock in the horizontal position. Here, the uprighting operation was carried out by gradually flooding the bottom portion of the leaf with the aid of 2in vertical pipes and valves which were fitted to the leaf. The centre bulkhead was made watertight for this operation so that the leaf could be trimmed, and a 15-ton cathead was erected on the dock wall to hold the leaf at its top. The pull of this cathead aided the buoyancy of the leaf and lifted it about 3ft above its freely floating vertical position, and this amount was sufficient to keep its underside clear of the lock bottom. Having been uprighted, the leaf was lifted into position by the "Mammoth."

The construction of an adequate deep-water approach channel in the River Mersey necessitated the removal of about 140,000 tons of sandstone and overlying silt. The Board's bucket dredgers were employed for this work, but in addition a rock breaker was chartered from the Tilbury Contracting and Dredging Company, Ltd., in order to facilitate the work and save wear and tear of the dredgers' machinery and buckets. The remainder of the work involved the excavation of about 235,000 cubic yards of masonry, rock and earth, and the placing of about 122,000 cubic yards of concrete.

The Engineer's drawing office was responsible for the design of all the work involved, including the design of the lock gates and the hydraulic machinery operating the gates and sluices. The total cost of the work was approximately £1,300,000. An illustration of the completed Waterloo River Entrance, from the north-east, is shown in Fig. 11.

The Institution of Naval Architects

SUMMER MEETING IN EDINBURGH

No. I

THE members of the Institution of Naval Architects, at the opening of their summer meeting at Edinburgh on Tuesday morning, June 28th, under the Presidency of Admiral of the Fleet Viscount Cunningham of Hyndhope, were welcomed, in the hall of the Royal Society of Edinburgh, by Bailie Stewart Lamb, representing the Lord Provost. The President, expressing appreciation of the kindly welcome extended to the Institution, said the occasion was the first in the eighty-nine years of its existence on which it had met in Edinburgh.

The first paper presented was "German and Japanese Battleships," by Dr. Oscar Parkes, O.B.E., M.B., Ch.B. (Associate), an abstract of which is begun on page 39.

Discussion

Mr. D. E. J. Offord, R.C.N.C., dealing with the protection of the ships discussed in the paper, said the author had detailed the type and number of hits which the "Bismarck" had received before she sank. It had been claimed that the "Bismarck" had taken a great deal of punishment; but by analysing the details one found that quite a lot of the damage was not such as would cause underwater flooding, and therefore, could not have contributed to her sinking. The underwater damage was not excessive for her displacement, which was 20 per cent greater than that of the "King George V" class.

Pointing to the rather doubtful criterion which was used in the paper and was often used in describing the protective values of ships, he said he did not think it fair to talk about the damage a ship received before she sank. The only true criterion was the damage that a ship was shown to have received when she returned to harbour. To talk of the damage she received before sinking was just as likely to be a tribute to the rate of firing by the enemy as to her own resistance.

The author had shown by his drawings that the "Bismarck" did not appear to have any special secret devices either in her armour disposition or in her underwater protection; he believed that was admitted. But the author had said that her great resistance could be attributed to the high quality of the armour plates, plus an exceptional beam which allowed torpedo bulkheads to be placed 17½ft from the sides. As regarded the armour, he had seen no evidence whatever that in its behaviour it was superior to British armour; indeed, there was no evidence that the ship was hit on her main armour belt. Concerning underwater protection we needed to be rather careful. Even when the protection had successfully withstood the attack, the bulge was flooded and so the edge of the water plane for initial stability purposes became the protective bulkhead. Thus, if the full amount of extra beam were devoted to extra depth of protection there might be no gain in stability or reserve of buoyancy after damage. The author had fallen into the old fallacy of simply adding armour thicknesses to arrive at total protection; that was quite wrong.

Mr. Offord found practically nothing to criticise in the paper concerning the protection of the "Yamato." Her armour disposition was sound and was, he felt confident, of the type that would have been adopted in this country if our ships had sufficient beam to provide adequate stability for so much top weight.

In his opinion the outstanding lesson to be drawn from the designs discussed, from the protection point of view, was not that the British naval constructors were outmatched in quality of armour, in constructional features, in bulge protection or watertight sub-division, but that they were most seriously handicapped by rigid and conscientious adherence to Treaty limitations and even more so by beam restrictions imposed upon them by Operational Requirements laid down by the Naval Staff.

Mr. Hans Volpich, commenting on a section through the "Tirpitz," which showed the torpedo bulkheads carried right through to the bottom of the vessel, said that the German Admiralty had adopted that practice also in former vessels such as the "Deutschland" and "Scharnhorst" classes. He believed the Germans had attempted to weld those bulkheads and had experienced a lot of trouble and, when they could see no other way out they had blamed inexperienced welders in the experimental stages. He asked whether, in the final edition, they had adopted welding or had resorted to riveting.

The high G.M. figure quoted for the "Bismarck" (13·12ft) was probably a record for a warship but there were at least

two merchant vessels of recent design in which the G.M. figure exceeded by several feet that of the "Bismarck." Asking whether the "Bismarck's" triple screws were of orthodox design, he said that the cruiser "Leipzig" had triple screws and that the centre screw was a patented, variable pitch propeller, which could be feathered when the vessel was driven by the turbines at cruising speed. Probably such a propeller would have been out of the question for the "Bismarck," due to her high power—about 55,000 s.h.p. per shaft being transmitted at top speed.

The "Yamato" had a rather uncommon rudder arrangement, both rudders lying on the centre line, one forward of the other. He presumed the forward rudder was used only in emergency because if both rudders were used together, quite an appreciable interference would have resulted.

Sir Charles Lillicrap (vice-president) said that close examination of the position showed that the main cause of the rapid growth of displacement between the "Baden" and the "Tirpitz" was due to the demand for increased protection. The "Queen Elizabeth" class, which were of an approximate standard displacement of 27,000 tons, had a fair measure of protection. But since that time plunging fire and the advent of the bomb had necessitated reconsideration of the problem of protection, and that involved heavy and thick armour decks.

Commenting on a section through the "Tirpitz" and "Bismarck," Sir Charles said the basic idea showed no advance whatever in the German design since the 1914–18 war. There was no appreciation of the increased menace of long-range fire and bombing; there was nothing in the design to warrant the view that the Gremans had appreciated fully the new conditions of warfare, except for the very big beam which, by cheating, they were able to give the ship and so obtain a large space outside the protective bulkheads, giving a certain amount of protection against torpedoes.

One could also appreciate from the diagram why the "Bismarck" in the circumstances was so difficult to sink. Aircraft torpedoes would not have a very considerable effect on that underwater protection. The great merit of the torpedoes dropped from aircraft was that they damaged the steering gear, crippling the ship and enabling our forces to overhaul her. From the diagram one could see why gunfire at close range smashed the upper thickness of protection, which was very thin, and the upper works, and reduced the ship to a shambles, but could not and would not have sunk her. Eventually she was sunk by torpedoes.

The handicap from which the British Admiralty had suffered in adhering strictly to Treaty limits, and the handicap inflicted by docking considerations, were very severe. He imagined that this country, and probably America, had learned their lesson against again undertaking Treaty obligations limiting our possibilities when there was no question of our enemies adhering to them.

The Japanese battleships, however, showed signs of the exercise of initiative, in taking the armoured bulkhead down inside and continuing it to form the base of the magazine, thus attempting to protect the magazine from underwater explosions. The Germans, on the other hand, seemed to have shown no cognizance that any such problem existed.

Finally, he found it difficult to understand why the Japanese had provided two rudders, both of them on the centre line. We had tried it in the "Royal Sovereign" class and, although the forward rudder in that class was a little smaller than that used by the Japanese, we had found it so ineffective that eventually it was taken out.

Vice-Admiral A. E. M. B. Cunninghame Graham, offering a defence for the Naval Staff—although he had never served on that staff—said it must be appreciated that they had had difficulties, as had the Royal Corps of Naval Constructors. It seemed fairly evident that what we all wanted in our warships was extra beam, for then we had more to play with. But, unfortunately, at present the provision of the extra beam was dependent on being able to dock the ships. Thus, one might throw the problem back to the scientists and technicians, asking them to devise a new method for making a more economic graving or floating dock; he could not believe that it was beyond the realms of science to provide a new method of docking.

Sir Stanley V. Goodall said the first thought that had come to his mind when he had read the first page of the paper was the extreme danger, in a matter of such vital importance as the strength of the Royal Navy, for a Government to put its trust in inky blots on rotten parchment bonds. There was a footnote by the author that Germany was not a signatory to the Treaty. Germany had affirmed that the standard displacement of "Tirpitz" and "Bismarck" would be 35,000 tons; we had been given the length, beam and draught, and, speaking from memory, he believed it was said that the draught was 26ft. His immediate reaction had been to ask the Director of Naval Intelligence if those dimensions could be confirmed, because they seemed utterly impossible or impracticable for a ship of 35,000 tons.

It was stated in the paper that Britain had ended the war with battleships smaller than those of the enemy powers, in terms which would rather suggest that that was something of which we should be ashamed. But Sir Stanley maintained that it was something of which the Naval Constructors and the Naval Staff should be proud, that we kept to the requirements and produced the ships which gave good service.

Speaking of the pre-1936 years, when the principal naval powers were engaged in the design of capital ships to meet the views of naval officers, Sir Stanley said the powers seemed to have agreed that the speed should be of the order of 30 knots, which, of course, presented considerable difficulties both to the naval constructor and to the naval engineer. We, in common with the Americans, had disagreed with the Germans and with the Japanese at first, but not later with the Japanese, in regard to the main armament. Taking into account the fact that the ships' displacements were to be limited, it was practically essential that we should adopt a concentrated main armament of quadruple or triple turrets, whereas the Germans were able to adopt twin turrets only because of the excessive displacement to which they were designing the ships.

In respect of anti-aircraft armament there was again a difference between the German and the British point of view. Finally, we had adopted a dual armament to deal with attack from surface craft and attack from aircraft as the main A.A. armament, with a secondary auxiliary armament, whereas in the "Bismarck" and "Tirpitz" there were 5·9in, 4·1in and 2cm guns. The provision of all the necessary controls for that armament was a problem which must have caused them very many headaches.

On the subject of protection, Sir Stanley recalled his own paper to the Institution in 1921 on the battleship "Baden," for there seemed no doubt, as Sir Charles Lillicrap had pointed out, that the extraordinary fact about the "Tirpitz" and "Bismarck" was that after nearly twenty years the Germans had produced a ship which was really just a blown-out edition of that which had served them during the 1914–18 war. The lesson which had been drilled into us after that war, when we came to design capital ships, was that there must not be a possibility of the repetition of the disasters at Jutland, when a ship was blown up after a short period of action. The horizontal protection for "Bismarck" and "Tirpitz," as shown by the drawings in the paper, was such as we still considered inadequate to resist plunging fire and armour-piercing bombs. That was shown by the fact that the "Bismarck," in her first engagement with "Hood" and "Prince of Wales," was hit by a shell bursting low down, with the result that an oil-fuel tank was opened to the sea and for a long while afterwards she had left a trail of oil in her wake.

The amount of underwater punishment which the "Bismarck" had taken had been linked up with discussion on her metacentric height. But Sir Stanley emphasised again that metacentric height alone was not an indication of a ship's stability; it was a rough measure, but other matters had to be taken into account, such as the extent of flooding, the size of compartments and the sort of damage which might result and which would reduce the margin of stability. Particulars given in the paper concerning the "Yamato" showed that quite a big margin of stability would be lost without the armour being pierced. In order to provide for that, no doubt the Japanese had decided that they must provide a big metacentric height, and the result of that would be a rather poor ship from the point of view of behaviour in a seaway.

The Japanese had given considerable thought to protection against attack from under the bottom of a ship; we also had had to give grave attention to that matter and finally had decided that all we could do was to rely upon water-tight sub-division. The arrangement in the "Yamato" required a lot of space; further, it was all very well to draw a thick line on paper, representing underwater protection, but in the actual building of a ship it was surprising what a lot of holes and openings had to be made in the plating, all sources of weakness.

Dr. Parkes, commenting on the reference to the quality of the armour of the "Bismarck," said he had a vivid recollection of being told by the late W. L. Wyllie that, when the "Baden" was a target for the "Erebus" and "Terror" at the end of the first world war, he had made sketches, and had shown one of the "Baden" receiving a hit. When asked if he had produced more, he said there was not time, for she went under before he could make a second sketch. Thus, under fire by 15in guns, she must have sunk within minutes. On the face of that evidence, one wondered how it was that the "Bismarck" had withstood so well the firing by the "Rodney" and other ships, that she had had to be finished off by torpedoes. Therefore, he had deliberately suggested in the paper that the "Bismarck" had a superior quality of armour, in order to be told that she had not!

In reply to Mr. Volpich, he said he would make enquiries as to whether the Germans had used welding and with regard to the design of the screws and the use of the rudders. With regard to the second rudder being ineffective, again he had been trying to learn something. But one wondered whether, if the "Bismarck" had had a

second rudder, the torpedo would have been so effective as in fact it was.

The President, proposing thanks to the author, said he would have liked to have heard more about the "Tirpitz." Perhaps information on what had happened to her was buried in the archives of the Admiralty. It was true that the armour-piercing bombs dropped by the Fleet Air Arm did not go off, although a small 500-lb bomb did explode. But the ship seemed to have succumbed fairly easily. He agreed with Sir Charles Lillicrap in the hope that the U.S.A. and ourselves had learned the lesson against being bound by treaties, and that in future we should have the ships we required and not the fancies of politicians.

The second paper presented at the meeting was "Frictional Resistance and Ship Resistance Similarity," by Professor E. V. Telfer. We give herewith the official summary.

After reviewing the present position of the subject of ship resistance similarity, the Van Lammeren tests of the geometrically similar series of models of the s.s. "Simon Bolivar" are examined in detail. The question of structural roughness resistance is then considered and a convenient standard is proposed which substantially agrees with the Froude coefficients.

A new type of extrapolation diagram is next developed which avoids direct use of Reynolds number. This follows from the enunciation of a new law of comparison possessing extreme simplicity. The presentation of frictional resistance by the new method is detailed and the corresponding presentations of the "Simon Bolivar" data are given and compared with the original extrapolation diagram.

The simplifications made possible in the presentation of normal ship and model data are discussed. The problems of wake and thrust deduction scale effects are considered and wake extrapolation for the "Simon Bolivar" is accomplished in the new extrapolation diagram.

Finally a few useful directions for further research in the subject are discussed.

Discussion

Dr. G. Hughes discussed the comparison of the lines proposed by Dr. Telfer with experimental data, mainly tank data, as well as ship data. The basis on which Dr. Telfer's lines were founded contained, he argued, an inherent weakness. There was danger in attempting to compress the infinity Reynolds' number into a finite space by inverting the functions. He felt that at present there was no real justification for accepting the proposed extrapolation in preference to other lines proposed. The matter, he added, was very much under consideration by the tank authorities, and he had not the slightest doubt that the method proposed by Dr. Telfer would receive very full consideration when it came to deciding what line we should ultimately use in this country.

Mr. W. Muckle said Dr. Telfer's work made a very thoughtful and excellent approach to the very difficult problem of frictional resistance. He discussed some of the details and added that although Dr. Telfer appeared to have dispensed with the Schoenherr line, he had at least given a Telfer line to which we could hang on.

Mr. W. P. Walker remarked that the paper was one for specialists, but perhaps some of the non-specialists might be put into the picture a little. Quite bluntly, the position was that for years those who were working in the tanks and had been making predictions from ship models had been comfortably ensconced in a rut which Froude had laid down for them. It was not surprising, therefore, that someone should come along and throw a spanner into the works. Whilst Dr. Telfer's paper might be open to much argument, it might very well be epoch-making, in that there was put before us an alternative comparison.

Dr. Telfer, in his reply, said that Dr. Hughes' remarks illustrated two completely different outlooks between two persons. There were those who liked to complicate and those who lived to simplify. Why try to complicate a problem so that another twenty years might elapse before we got down to practical politics? The Froude method had worked for seventy years and we were trying to streamline the theory.

(To be continued)

German and Japanese Battleships*

By DR. OSCAR PARKES, A.I.N.A.

The German Battleships "Bismarck" and "Tirpitz"

During the 1914–18 war the Germans completed two 28,000-ton battleships, "Bayern" and "Baden," mounting eight 15in guns and steaming at 21 knots—which by the Peace Treaty restrictions should have been their last outsize capital ships. Twenty-five years later, during the 1939–45 war, history was repeated to the extent that the Reich passed into service two monster vessels, "Tirpitz" and "Bismarck," also mounting eight 15in. guns, but with a speed of over 30 knots and displacing 51,000 tons at full load. Again, we expected them to be the last German capital ships.

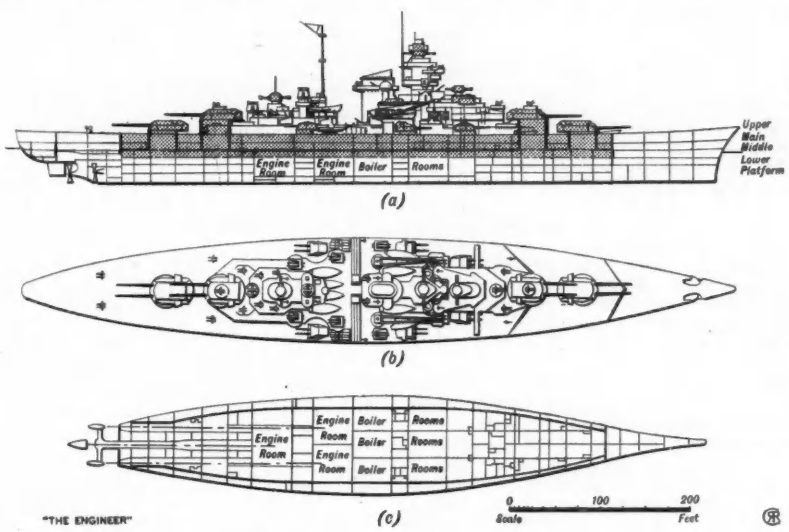
The "Bismarck" was laid down at the Blohm and Voss yard in July, 1936, launched on February 14, 1939, and completed in August, 1940; "Tirpitz" was begun in October, 1936, took the water on April 1, 1940, and commissioned in February, 1941.

Design.—In general both ships represent a heavy battleship edition of the "Scharnhorst" class, but with four twin instead of three triple turrets, their noteworthy feature being the reversion to twin mountings. After a marked partiality for the triple grouping as shown in their "K" class cruisers, the "Deutschlands" and the "Scharnhorsts," the Germans reverted to twin turrets in the 8in gun cruisers of the "Hipper" class (1935) and maintained this preference in the "Tirpitz." At a time when Great Britain and France were installing quadruple mountings, while the Americans, Italians and Japanese were favouring triples, such a reversion was remarkable.

As constructional advantages, multiple mounts allow for a heavier armament in fewer turrets, with saving of weight and deck space, magazine and shell rooms, together with their horizontal projection, and side armour generally. Their chief objection is the liability to more gun loss due to turret damage, and certain firing stresses, which can, however, be met by changes in salvo grouping.

From inquiries in Germany before the war (which were confirmed recently) it was understood that there were no technical reasons for the change to twins, which was due to naval prejudice. Until 1934 technical advice was predominant in deciding certain features of German ships, including the disposition of armament. To install the heaviest armament in vessels of restricted tonnage, triple mountings were adopted in armoured ships and cruisers between 1926 and 1934. But high-ranking officers were grimly opposed to this change in tradition and the traditional firing system with twin guns, and despite the alleged favourable results with triples, they pressed for a reversion to the time-honoured twins. Seemingly they would never have had their way but for Hitler's rise to power. In his eyes the opinion of his naval advisers ranked higher than that of the technicians. But there is reason to believe that German triple mounts had to go through a lengthy period of teething troubles, so that naval opinion pressed for a heavier and thoroughly reliable twin mount which would be brought into action with confidence and no expectation of breakdowns.

Dimensions.—As each nation was building its warships under conditions of secrecy, there could be no check upon the dimensions of the battleships alleged to be of 35,000 tons. But a comparison of the figures tabulated below shows how wide was the divergence from those of the British and American designs, neither of which exceeded the agreed standard tonnage:—



(Armoured areas and positions are stippled.)

Fig. 1—"*Tirpitz*"

	Length overall ft	Beam ft	Draught ft	Displacement tons
"Tirpitz" ...	820⅔	118⅛	31½	42,000
			34½	51,000
"Richelieu"...	804	108½	26½	35,000
			35	48,500
"Italia" ...	774	106	28	*35,000
			30½	45,752
"Washington"	728½	107¾	26¾	35,000
			35½	42,000
"King George V"	744¼	103	27¾	†35,000
				44,500

* According to Italian naval sources the standard displacement is 41,167 tons.

† 35,000 is the designed standard displacement; the deep displacement includes additional protection, anti-aircraft armament, &c., fitted during the war.

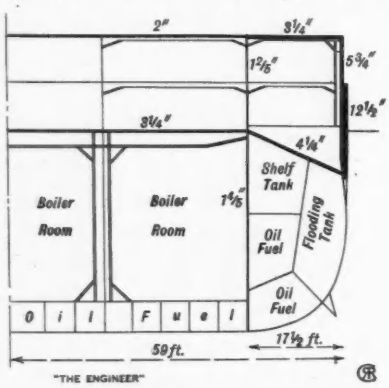
Hull.—The weather deck ran flush from stem to stern with a sheer fore and aft, the bow freeboard being 27ft, with 15ft amidships and 19½ft right aft. There was a considerable overhang

* Institution of Naval Architects, Summer Meeting at Edinburgh. Abstract.

to the stem with a bulb-shaped foot and no cutaway; the curved stern followed conventional German lines, with a marked deadwood cutaway and twin rudders abreast in "Dreadnought" fashion. The absence of scuttles except at the extreme bow and stern marked the presence of main deck armour and need for an extensive system of artificial ventilation (Fig. 1).

It will be noticed that the maximum beam was right amidships, with immediate fining towards the entry and run—in marked contrast to the long parallel topsides of the "Yamato" (Fig. 3).

Subdivision.—It was found from examination of the "Tirpitz" wreck and drawings that the watertight subdivision was generally similar to



Section beneath tower mast to show horizontal armour and subdivision external to torpedo bulkhead.

FIG. 2—"*Tirpitz*"

Admiralty practice. It may be noted, however, that every transverse watertight bulkhead in the ship was pierced by watertight doors on the first and second platform decks.

Armament.—The eight 15in guns were carried on two levels only, 28½ft above the draught water line for "A" and "D" turrets and 37½ft for "B" and "C," thus facilitating control by the range-finder directors at the mast head and on the after superstructure. No ballistics are available for these guns, but at full elevation of 45 deg. their maximum range was 41,300 yards. Ammunition supply was 108 shells per gun.

For their displacement the turret armour was less than would have been expected and well below British and American standards in pre-war battleships. By sloping the upper third of the sides, face and rear at 45 deg. a considerable saving in weight was gained and the armour could be thinned without much loss in protection. Thus, the faces were 14in with a 7in slope, sides 8·6in to 5·9in, rear 12·5in to 7in, and crown 5in only. Barbette armour was on the same scale and less than usual standards, with 13·5in above the weather deck and 8·6in below it and behind the citadel armour.

The secondary armament of twelve 5·9in guns was disposed in three small turrets aside made of 1·6in plating. By placing the foremost turrets well inboard the second pair could be trained dead ahead, allowing a nominal eight-gun concentration; the third pair trained astern. These were not dual-purpose weapons, but had 45 deg. elevation only and a range of 27,000 yards. Control was by two range-finder directors. Ammunition supply 105 shells per gun.

As in H.M. ships, the air defence armament was progressively increased during the war. Both ships carried sixteen 4·1in guns in pairs along the superstructure deck, ranging up to 17,000 yards with 70 deg. elevation. In addition, the "Bismarck" had sixteen 2cm. in quadruple mounts—twelve in pairs and eight as singles; but during her longer life "Tirpitz" had this battery increased to forty-four 2cm in quadruples, sixteen in pairs and ten on single mounts, making seventy in all. In addition to these, two quadruples were placed on the quarterdeck when in harbour (as shown in Fig. 1).

A set of quadruple torpedo tubes (21in) on each beam was carried just abaft the catapult in "Tirpitz" only, as an addition to her original armament.

Aircraft.—Four aircraft could be stowed in the hangars amidships, and it was originally intended that the house with the sloping roof abaft the second turret should be a hangar with a catapult on the turret roof. This plan was subsequently abandoned and the house suppressed, but some months later it was ordered to be installed again. When it had been built in there was again a change of mind, and the builders were ordered to remove it; but this time Blohm and Voss said "No" to any more chopping and changing and fitted the structure as a staff quarters.

Protection.—In the past the outstanding feature in the protection of German battleships had been their heavier plating compared with contemporary British ships and the more extensive subdivision made possible by their greater beam. As the "Bismarck" was able to sustain such heavy attack from gunfire and torpedo between May 24–29, 1941, before being sunk, particulars of her protection may be of some interest. It will be remembered that she remained afloat after having suffered three hits by 15in shell, two by aircraft torpedoes, two by destroyer torpedoes and one from a "Rodney" 24½in torpedo, with subsequent heavy pounding by gunfire until a further torpedo on each side from the "Dorsetshire" put her under. It will be seen that her plating was not on the heavy side, as in the "Yamato," nor the system of subdivision anything out of the ordinary, so that her stubborn resistance must be credited to high-grade quality armour plus an exceptional beam which allowed the torpedo bulkheads to be placed 17½ft from the sides and secured a well subdivided hull in which big spaces were avoided (Fig. 2).

The system of armour protection was on conventional lines for 8ft above and below the load water line; above this the main deck side was 5½in in contrast to the "King George V," "Washington" and "Richelieu," in which it is left bare under the "all-or-nothing" system. Horizontal protection lay in the flat upper deck of 2–3½in plating and the main deck rising from the lower edge of the belt, which afforded 3½in on the flat and 4½in on the slopes over the machinery spaces, and 4in and 4½in respectively over the magazines, giving a maximum of 8½in including the intermediate plating.

A 4·3in deck covered the steering gear.

The conning tower was a shallow structure of 13·9in N.C., placed in the forward superstructure, with a narrow communication tube leading down to the main protective deck.

A double layer of tanks, 17½ft across, separated the 1·9in torpedo bulkhead from the ship's side, and the compartmenting placed between the engine and boiler rooms should be noted (Fig. 1).

The total weight of armour was 17,510 tons (metric).

Stability.—With her comparatively low freeboard, great beam and full underwater form it was only to be expected that the G.M. would be on the high side. According to German sources, it was no less than 4m (13·12ft), which so far as is known, stands as the highest recorded with the exception of the United States monitors of the "Miantonomoh" class (1863), which worked out at 15ft. No account of behaviour at sea is available.

Propulsion.—According to German sources, the "Tirpitz" and "Bismarck" were the first German ships designed to have turbo-electric drive, with three Brown-Boveri geared turbines (three screws) and twelve Wagner boilers. With 150,000 h.p. the designed speed was 29 knots, realising a maximum of 30·9 knots at 50,000 tons when developing 163,000 h.p.

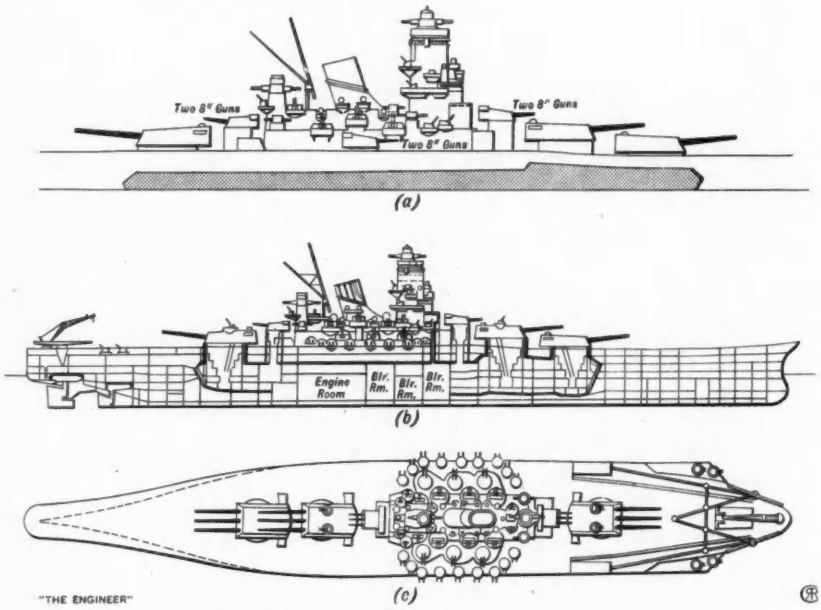
Being specially intended for raiding, they were given exceptional endurance, the figures known in this country being 10,000 miles at 23 knots with 45,000 h.p. when loaded with 5000 tons plus 1000 tons emergency oil fuel. The German figures are 10,000 miles at 19 knots with 7654 tons (metric).

Complement.—The peacetime complement would have been 1988; during the war the ships carried 2200 officers and men.

General.—A full complement of boats was carried, which were handled by cranes on each side.

The Japanese Battleship "Yamato"

Design.—In considering Japanese designs allowances must be made for certain difficulties



(a) To show the 8in gun turrets, A.A. gun distribution and armour belt as first Commissioned, 1941

(b) To show armour decks over steering positions, barbettes, and beneath magazines

(c) Showing final distribution of A.A. guns

FIG. 3—"*Yamato*"

under which their naval architects worked. Being a nation of copyists, they had relied upon foreign tuition for their future constructors, and as Britain and France accepted pupils for advanced training in naval architecture, so design methods and practices were those learned in these countries. But in 1928 a rigid and one-sided secrecy which Japan thought fit to observe about her new construction ended this arrangement, and the admission of Japanese students to Greenwich came to an end.

Thus deprived of their main sources of

up-to-date technical knowledge at a period when warship construction was beginning to undergo considerable developments and improvements, the Japanese experienced a great lack of basic design information which could not be built up without years of research and a background of practical experience. Now the history of big warship building in Japan is comparatively short, their first capital ship home products being the battleships of the "Satsuma" class and that curious hybrid the "Tsukuba," all begun in 1905. But when they wanted battle-cruisers the "Kongo" was ordered in England in 1911 and the rest of the class built at home from her design. From 1928 much of their data had to come from foreign publications, and in some cases it was nesessary to rely upon out-dated formulæ.

Rather than attempt the intricate calculations entailed by such a design as the "Yamato," they fell back upon data derived from ships in service which could be scaled up as requisite.

Although within recent years Japanese designs have presented certain bizarre features such as pagoda masts and wavy deck lines, our observers after VJ-day reported but few instances of outstanding originality in their practice and new types generally followed those already built. But in certain cases, such as the run of uptakes in carriers, and the armour protection in the "Yamato," problems had been tackled with boldness and initiative.

The design of the "Yamato" was begun in 1934, but owing to the fresh problems presented by nearly every factor in it three years elapsed before a start could be made on her construction at the Kure Navy Yard, and on her sister at Nagasaki. Both were completed in 1941, shortly before hostilities began, and shortly afterwards were remodelled amidships for a much stronger anti-aircraft equipment. The decision to build two such monsters, together with the ordnance and equipment required, instead of three or four less portentous units must be regarded as one of the most vital ever arrived at in the history of battleship construction, on a par with the adoption of Reed's "Devastation" in 1869 and Benedetto Brin's "Duilio" in 1872.

Hull form.—The overall length was 863ft (exceeding that of the "Hood" by 2½ft) and 800ft b.p.; water-line beam 121ft, with a maximum deck beam of 127ft; load water-line draught 34ft, with 35½ft at full load, giving a standard displacement of 63,000 tons, trial displacement 69,935 tons, and full load 72,200 tons. The high L/B ratio of 6·6 to 1 and great length was to secure speed without exceeding a reasonable propelling power.

As in most Japanese ships of recent design, the outstanding feature in hull form was the peculiar sheer line rising and falling in waves, highest at the bows and amidships, and, owing to the 'tween decks hangar aft, with a slight fall towards the stern instead of the usual marked drop. This line was based upon purely utilitarian considerations. At the bows the sharp sheer was for seaworthiness; amidships, where there was a rise almost to bow height, freeboard was determined by range of stability; aft it was customary to make the stern as low as possible in conformity with the depth of hull required for gun positions. These heights having been determined, the points were connected by straight or slightly curved lines giving an unbroken deck, which saved structural weight and avoided notching the ship's girder by dropping the main deck one level to the freeboard required aft.

The bow was unique in the Japanese navy in having a marked overhang and a bulbous foot, contrasting strongly with the usual cutaway bow in other types. U-shaped and especially bulbous sections at the bows tend to reduce wave formation forward, since the excess pressures formed at a great depth below the water-line can only be partially relieved by the creation of surface disturbance and help to pump the water aft where it is needed. The projecting ram-shaped stem enabled the designer to obtain a fine entrance angle of the water-line in the way of the bulb, which increased the effective length of the ship, and was reported as being responsible for a 5 or 6 per cent diminished resistance (*Speed and Power*, page 94).

Aft she was equally unorthodox in having two rudders and the deadwood cut away to an unusual extent, with an eye to better propulsion than to steering. The rudders were in the same longitudinal centre-line, that forward being half the area of the after one. Both were equipped with complete electro-hydraulic steering engines, being so separated as to prevent loss of steering control if one or other rudder were damaged.

Another characteristic of Japanese ships was their comparatively low midship section coefficient, the shape of the maximum section, usually abaft amidships, having a large bilge radius with a considerable rise of floor. In the "Yamato," however, it will be seen that the floor is flat and the turn of the bilge under "B" turret is but little slacker than in some of Great Britain's recent designs at the amidships section.

Construction.—Although the Japanese laid great stress upon saving in weight, they were never able to take full advantage of the saving due to welding owing to lack of experience, and the want of welding rods capable of more universal application than those available. When used, welding was applied principally to mild steel and to steel of slightly higher strength than mild steel.

The initial success achieved in the case of the light-minelayer "Yaeyama" (1933), which was welded throughout, was not repeated in the light cruiser "Mogami," which ran her trials in 1935. When firing 6in salvoes while at full speed the welding in the hull structure near the stern developed cracks with severe leakage, which put her in dockyard hands for several months. After this, welding was abandoned in large ships so far as the general structure was concerned.

By virtue of the extensive use of high strength DS steel, higher stresses were allowed for design purposes than would have been the case if mild steel had been used.

(*To be continued*)

Spreading the Winter Electricity Load

It was announced by the Ministry of Labour and National Service on Tuesday, July 5th, that arrangements have now been made for spreading the industrial load next winter. The Electricity Sub-Committee of the National Joint Advisory Council has recommended some easement in the contribution to be asked of industry and the Government has accepted that Committee's recommendations. During December, January and February as compared with the maximum load during the corresponding period of 1946–47, industry will be asked to cut its maximum peak demand on Mondays to Fridays inclusive by 20 per cent during the hours of 8 a.m. to 10 a.m., but during the hours of 10 a.m. to 12 noon the reduction asked for will only be 10 per cent. From December 1st until January 15th a reduction of 20 per cent will also be necessary between the hours of 4 p.m. to 5.30 p.m. on Mondays to Fridays inclusive, but after that date the problem of the afternoon peak is to be left to the discretion of the Regional Boards. As last winter, arrangements to achieve these reductions should again be worked out by the Regional Boards for Industry and their committees with the firms concerned; any additional load connected since 1946–47 should be taken into account by the Regional Boards in order to ensure appropriate contribution. The Regional Boards will also make such arrangements as they consider appropriate in the light of regional circumstances for the "fringe months" of October, November and March. To achieve the target reduction it will be necessary for the Regional Boards to ask some firms in appropriate cases to make an extra reduction in respect of their particular loads, but it is not intended that the general figure of 20 per cent should be exceeded over large areas. The Government states that it is not enough to make these arrangements to reduce the consumption of electricity by industry during the peak periods; other classes of consumers must also make a contribution proportionate to their demand and it has therefore been decided that, as in last winter, commercial consumers, including shops, offices, warehouses, hotels and cinemas, should be brought within the scope of the arrangements made by the Regional Boards for Industry and that they should be required to reduce their consumption by the same amounts and during the same hours as industry. The Ministry of Fuel and Power and the British Electricity Authority and its Area Boards will also take appropriate steps to ensure that domestic consumers and small commercial consumers exercise the fullest economy in the use of electricity during peak hours.

British Overseas Airways Corporation

On Thursday, June 30th, Sir Harold Hartley, F.R.S., retired from the chairmanship of the Board of British Overseas Airways Corporation and was succeeded in that position by Sir Miles Thomas, who we may recall, has been deputy-chairman of the Board since April 1, 1948. Mr. Whitney Straight succeeds Sir Miles Thomas as deputy-chairman. As was recently announced in the House of Commons by Mr. G. S. Lindgren, the Parliamentary Secretary to the Ministry of Civil Aviation, it is intended on the passing of the Airways Corporations Bill now before Parliament that Mr. J. W. Booth, at present a member of the Board of British Overseas Airways Corporation, will become an equal and joint deputy-chairman with Mr. Whitney Straight. The other members of the Board of British Overseas Airways Corporation are Major J. R. McCrindle, Lord Burghley, Major R. H. Thornton, Sir Clement Jones, and Mr. H. L. Newlands.

Fifty Years at Annan.—We have just received from Cochran and Co., Annan, Ltd. a brochure commemorating the construction and development of the Cochran boiler from 1899 to 1949. The booklet is illustrated with interesting photographs and events covering this period. The firm of Cochran and Co. was started in Birkenhead in 1878 and was engaged in general engineering and shipbuilding work, the partners being Mr. Edward Crompton, the inventor of the boiler, and Mr. James Taylor Cochran. In 1898 the firm moved to Annan, Dumfriesshire, and was re-styled Cochran and Co., Annan, Ltd. Shipbuilding was continued alongside boilermaking till 1901, when work was concentrated upon the manufacture of Cochran boilers. From the first these boilers were largely used as donkey boilers on ships, and from 1913 onwards the use of oil fuel was studied and successful results obtained. During the first World War production was controlled by the Admiralty and Cochran boilers were applied to a variety of useful purposes. Later, the use of the boiler for steam production on motorships was extended, use being made of exhaust gases for heating. For many years the firm made steam accumulators for Ruths and in 1944 a controlling interest was secured in the Ruths business, which is now incorporated into the Cochran organisation under the name of Ruths Accumulators (Cochran), Ltd. The advantages of the Sinuflo tube, invented by Percy St. G. Kirke, were early recognised, and from 1934 an agreement with the patentee was made and the design and production of both vertical and horizontal Economic boilers were added to the Cochran range. The second World War found the Cochran boilers, built ready for dispatch, of great assistance for heating service buildings, and between 1939 and 1945 a variety of boilers for wartime needs were supplied. The company also assisted with the building of tanks and with the Mulberry harbour scheme. The works have been extended and new offices built with a works canteen, and in 1945 a new machine shop and loading bank were constructed. In 1946 welding was developed for pressure vessels, and the firm was recognised by Lloyd's Register of Shipping for the production of Class I welded pressure vessels. Throughout the history of the firm relations with the workmen have been most happy, and in 1919 a works industrial council was set up, which has worked extremely well.

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NOTICE TO READERS

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No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

For Subscription Rates see page 2 of Advertisements.

THE REFINING OF NON-FERROUS METALS

IT is opportune that the forthcoming Empire Mining and Metallurgical Congress, which covers a very wide range of metallurgical interests, should be preceded by a Symposium on the Refining of Non-Ferrous Metals, organised by the Institution of Mining and Metallurgy. For the attainment of a high degree of purity in many of the non-ferrous metals has been an outstanding achievement of the period between the two wars, and merits special attention. Large tonnages of copper, lead, tin, zinc, aluminium and magnesium are now commercially available in a state of purity approaching or exceeding 99·99 per cent, at prices not greatly in excess of those of the so-called "commercial" grades. In a number of instances the elimination of the last small traces of an impurity or the reduction of the total amount of all impurities to less than 0·01 per cent has resulted in an unexpected reduction of hardness, improvement in malleability and increase in resistance to corrosion. The effect on the mechanical properties of the removal of impurities is nowhere better seen than in the rarer metals. The production of ductile molybdenum, titanium and zirconium is rendered possible as a result of the increased purity of the metal, just as ductile tungsten of high purity became a commercial product about forty years ago. It seems probable, however, that these metals will have very few applications in the very pure form, but that selected additional elements will have to be introduced in controlled quantities to modify the working characteristics, recrystallisation temperatures and mechanical properties of the metals in the massive state. There are, moreover, very few technical uses to which the more common metals can be directly applied in the pure or approximately pure state. Relatively pure tin and zinc are employed as protective coatings. The use of very pure copper and aluminium as electrical conductors on a large scale is limited by the weakness of the metals. Lead of "five-nines" purity (i.e., 99·999 per cent) is obtainable for chemical purposes, but creep is a difficulty when lead of such a high purity is used in large-scale plant. When any considerable degree of mechanical strength is required, pure or nearly pure metals cannot be used. Alloys must be employed.

The question then arises as to whether it is worth while securing a very high degree of purity in metals which will finally be used for the production of alloys. The answer will depend on the circumstances, both technical and economic, of each particular case. Not all impurities are injurious, and provided they are known not to interfere with successful and regular production of alloys of the grade required, there would be no justification for incurring the additional cost of high-purity metal as compared with that of the ordinary commercial material. Knowledge of the effect of small amounts of impurities, either separately or in association with each other, is, however, still very limited. Even when precise knowledge indicates that a particular impurity is not detrimental, but rather beneficial, for the purpose in view, better and more regular results are usually obtained if the desirable element is added in controlled amount to the pure metal rather than that it should be derived from the raw materials. In other instances the detrimental effect on the properties of an alloy of impurities present in the component metals is well established, and very high purity and regularity of composition are essential. In such circumstances the purest available metals find a ready application. An outstanding example of this is to be found in the zinc-base die-casting alloys. The early types of zinc-aluminium or zinc-copper-aluminium alloys were unsatisfactory owing to failures due to corrosion, swelling and cracking. From trials carried out under the auspices of the American Society for Testing Materials, and from results of other investigations published by the Imperial Smelting Corporation, it became clear that the intercrystalline corrosion and dimensional instability of these alloys were due to incorrect composition and particularly to the presence of small amounts of lead, cadmium and tin introduced by the low grades of zinc then used. A remedy was found in the almost complete elimination of these elements, which was made possible by the introduction of zinc of purity greater than 99·99 per cent. This prepared the way for the great expansion of the zinc-alloy die-casting industry during the war, when, at the peak of production, about 10 million zinc-alloy die-castings per week were being supplied to the services, with substantial economy of man-hours and material as compared with other methods of production of the same components.

The term "refining" was generally interpreted by the authors who contributed to the Symposium as covering the removal, wholly or in part, of the various impurities contained in the metal obtained from the smelting operations. The methods described include chemical refining (or the solution of impurities by chemical reagents), fire refining (or the removal of impurities by selective oxidation), electrolytic refining and distillation; or some combination of these. The metals dealt with at successive sessions were gold, silver and platinum; copper, bismuth and cobalt; lead, zinc, tin, tungsten and zirconium; aluminium, magnesium, chromium, manganese and low-carbon ferro-chromium and ferro-columbium. The Symposium was, of course, not confined to a consideration of metals of super-purity. Such products, though important, are not at present attainable in some metals at reasonable cost, and are not economically suitable for all applications. The production of the principal non-ferrous metals in a state of high purity is, however, now well established. If their advantages are to be realised and the effects of high purity maintained, a serious responsibility rests upon those engaged in casting and working the alloys prepared from them. Elaborate precautions against contamination are necessary. Pure metals and their alloys, whether liquid or solid, hot or cold, readily take up impurities from refractories, fuels, crucibles, moulds, furnace atmospheres and rolling mills. General cleanliness in casting and in the use of reclaimed scrap is an obvious requirement. Spectrographic methods of analysis are invaluable in the control of refining operations, and are a most useful means of detecting any failure to maintain the high standard of purity of the component metals during the preparation, working or subsequent fabrication of an alloy. Any increase in the amount of a deleterious constituent can be recognised and the presence of unsuspected elements can be detected with certainty. In organising this Symposium, the Institution of Mining and Metallurgy has rendered a service to users, as well as to producers, of high-grade metals which, to an increasing extent, form the basis of engineering materials of improved quality and wider application.

SECRECY AND INVENTIONS

LITTLE as the present restrictions on the dissemination of certain classes of scientific and technical information are liked, it would be unfair to blame the politicians who compose our governments, here and elsewhere, for their restrictive measures. Some recent discoveries have proved to be potentially so dangerous to humanity that it seems their plain

duty to those in authority to do what they can to control the situation. But such action by governments in respect of the open circulation of scientific knowledge brings about a number of consequences. It seems to have led, for instance, to some scientists claiming a voice in government policy, as in the current controversy in the U.S.A. over the administration of its Atomic Energy Commission, where, according to Press accounts, it is hinted that scientists might refuse their co-operation if the control of atomic energy were retransferred to the Army. There are therefore two sides to the picture, and certainly the scientific world is apprehensive of the consequences which may follow from the limitation upon the freedom of publication to which it has been accustomed for so long.

To the scientific world "iron curtains" of this or any other sort are anathema as they necessarily hinder co-operation in the exploration of the laws of nature. Engineers share this state of apprehension but they have in addition a particular reason of their own for fearing this narrowing of the field of disseminated knowledge. They are apprehensive of its effect on the range and scope of invention. In the hard economic conditions of the present time and especially in an industrial country with a dense population like Britain, it is necessary to live in some measure by one's wits. One of the means so open is ingenious invention. From the days of Watt and his steam engine, invention has been a factor in the life of this country, whose importance it is impossible to exaggerate. If it was important in the stable, peaceful times of the nineteenth century it is still more so to-day. For not only are the economic difficulties, after two world wars, much more formidable, but there is the pressing need to increase the efficiency of our defensive organisation lest those wars should be followed by a third. New methods of attack have been devised and we must needs be prepared with equally novel means of defence. The exploration of the latter calls for wide knowledge, high ingenuity and intense industry. Can our defence departments be relied on to provide unaided these essential qualities, or must they look for assistance—as they certainly had to do in the last war—from outside, whether from industry or the universities? The technical experts employed in the days of peace by the defence departments have unrivalled knowledge of the problems to be met, as well as a great measure of ingenuity in meeting them; but wartime experience shows how great can be the assistance given by men from other walks of life, not least from those engaged on pure research at the universities. An outstanding example was the remarkable migration from the Cavendish Laboratory at Cambridge to the Telecommunications Research Establishment at Malvern, with results of outstanding brilliance; but once the war was over most of these senior men returned to the bases from which they came. That did not mean that all the problems on which they had been engaged were solved, but that other duties called them. No one can doubt that with their genius for discovery they could still assist by making fruitful suggestions towards the solution of many Service problems along profitable lines. But they could do so only if they were fully apprised of the relative facts, which under conditions of secrecy, harshly interpreted, would not be possible.

The situation may therefore arise in which those who have access to the latest technical knowledge have not the range of genius to profit by it fully, whilst those with abundant skill in exploring Nature's secrets are so out of touch with the current problems facing the defence departments as to make it hardly worth while for them to give consideration to such matters. That could well be so great a misfortune to the State as to make it important to consider the steps needed to meet such an awkward and entirely unsought situation. Some scientific men, impatient of secrecy, urge the abandonment of all restrictions on publication, leaving it to all countries to start equally "from scratch." But such freedom, it must be feared, would make things too easy for States bent on aggression. With no secrecy of any sort permitted—at any rate to those who obeyed the regulations—they would know exactly what defence measures were being prepared in neighbouring States and could therefore select out of the many modes of aggression just those which would most easily find the chinks in the victim's armour. There are, certainly, objections to secrecy procedure of any sort. But in these days there are even more dangers in doing entirely without it. It could, however, surely be required that the security regulations shall not be so strictly drawn up as to prevent selected men outside the defence departments from being kept generally informed, whether by personal visits, sharing in conferences, or even by means of secret memoranda, of the nature of current problems, as well as of the practical conditions which would need to be taken into account in any suggested form of solution. It may, of course, be the case that something of the kind is already under consideration. We certainly hope that it is.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

RAILWAY ROLLING STOCK

SIR,—Referring to the leading article in the issue of June 24th, in connection with British Railways, it is a moot point as to whether the authorities pay any attention to the views of the travelling public.

One region has followed up its hideous engines in the "modern" style by going to the opposite extreme and introducing "Olde Worlde" tavern cars with the exterior lined to represent brickwork and fake oak beams in the ceilings! Could any spectacle be more incongruous than a train of faked brick-walled tavern cars headed by one of the ugly, modernistic, engines?

Probably only a very small minority of the public is interested in the appearance of locomotives, but the tavern cars cannot fail to offend the good taste of the majority of railway travellers. As for comfort, one might as well travel in a guard's van. Presumably the designers of these monstrosities are proud of their efforts, but do they imagine that their creations will induce one single extra passenger to travel by rail?

One wonders if rolling-stock designers ever travel by rail, or are aware of the congestion and delays at stations through the use of corridor stock with entrances and exits confined to each end of the coaches. Passengers leaving a train have to fight their way through mobs trying to gain an entrance, and any passenger a little slow in leaving a compartment has to force his way along the corridor in the face of the passengers streaming in to look for seats.

A more serious drawback of current designs is the plight of passengers trapped by fire, as recently occurred in a main line passenger train.

The older design which provided each compartment with a door remote from the corridor, and a number of doors in the corridor also, afforded the maximum amount of convenience and ensured that trains could be emptied and filled quickly. The slight economies in construction effected by the elimination of these doors does not compensate for the trouble and confusion due to lack of them.

Presumably, in due course we shall be informed that the public does not want compartment stock, although the search for an "empty" is still very common and appears to be the habit of many passengers. Compartment stock also gives the unfortunate non-smoker a slight chance of travelling in an atmosphere fit to breathe. In this respect the number of passengers who heed the "Non-Smoking" label is daily decreasing.

E. B. PARKER

Wirral, Cheshire, July 1st.

LOUGHBOROUGH COLLEGE

SIR,—The year 1949 brings the retirement of Dr. Schofield, the Principal of Loughborough College since its inception in 1918.

Dr. Schofield's retirement will mean to many the passing of a milestone in the history of Loughborough College. His original and progressive ideals, which he pursued at times against the strongest opposition, have left their mark not only in the structure of Loughborough College, but in the wider fields of education, both nationally and internationally. They are too well known to need enlargement from me.

The Past Students' Association is particularly anxious to mark this occasion in a fitting manner and wishes to make contact with all those past students whose addresses are no longer known. Ideas for a suitable presentation were fully discussed at the last meeting of the Past Students' Association on June 18th, and full details will be sent to any past student whose address is received.

As so much of the work of Dr. Schofield, of Loughborough College, was done in the training of engineers, may I, in the hope that many of them are readers of THE ENGINEER, issue an appeal on behalf of the Association for them to write in to the Joint Honorary Secretaries of the Association at Loughborough College, giving details of their whereabouts?

It is felt that the occasion is one of such importance that every effort should be made to render the presentation truly representative of the many students in whose life Dr. Schofield played such an important part.

M. G. SATOW, President
Past Students' Association

Co. Durham.

EYEMOUTH BRANCH LINE, BERWICKSHIRE.—The Scottish Region of British Railways announces that the Eyemouth branch line, Berwickshire, has now been reopened for traffic. The branch, it will be recalled, had to be closed last August on account of the damage caused by heavy rainfall. The repair work has included the reconstruction of the viaduct across the Eye water, one of the piers of which was completely washed away.

The Royal Show at Shrewsbury

No. I

THIS year's Royal Show was opened at Shrewsbury on Tuesday last, July 5th, and closes to-day, July 8th. It is being held under the presidency of H.R.H. The Princess Elizabeth, Duchess of Edinburgh, and is certainly one of the largest—if not the largest—to be organised by the Royal Agricultural Society of England since its inception 112 years ago. The show has been held on three occasions previously in the immediate vicinity of Shrewsbury, the first being in 1845, when the exhibits totalled 942 implements, and 437 head of stock. At that time, there was no railway communication from London beyond Wolverhampton, and it is recorded that many visitors to the 1845 "Royal" completed their journey by coach!

It is by no means easy to estimate the number of machinery and implement exhibits at this year's Royal Show. They are displayed on no less than 660 trade stands—compared with 550 at York last year—and are said to cover an area of approximately fifty acres. The vast range of machinery exhibited certainly covers every requirement of modern agricultural practice, and gives yet another indication, if one is needed, of the important contribution that engineers are making to food production, both at home and overseas. The new implement competition, organised annually by the Royal Agricultural Society, has again proved an attractive and useful feature of the Show. More than sixty entries were originally submitted and twenty-eight of them were finally selected for adjudication this year. The judging in this competition was in the capable hands of Dr. Cornelius Davies, of the National Agricultural Advisory Service and the immediate past-president of the Institution of British Agricultural Engineers, and Mr. E. R. Jackson. Another special feature of this year's programme was a parade in the Grand Ring of British-made farm tractors.

In what follows we begin a description of some of the numerous implements to be seen at the Show. The greater part of the present article deals with entries accepted for the new implement competition.

ALDERSLEY ENGINEERING COMPANY, LTD.

Engineers and farmers have given a good deal of attention in recent years to problems connected with the satisfactory drying of grain and green crops, and the range of equipment devised for that purpose is being steadily increased. A recent addition is the mobile "All-Crop" drier which is exhibited by Aldersley Engineering Company, Ltd., Tettenhall, Wolverhampton. The machine, which is illustrated in Fig. 1, was entered for the Silver Medal Competition. It has been designed for drying grass, hay, corn in the sheaf, grain, and also hops and herbs, and its main unit consists of a trailer carrying an oil-fired furnace fan, ducting, and air-control slides. As shown in the engraving, this equipment is surmounted by a service oil tank of 100 gallons' capacity. At the rear of the trailer an anchor plate is provided, which is forced into the ground when the plant is set for operation, thus keeping the equipment steady and also taking the pull of the belt from the tractor. At the front a robust screw-jack is placed to aid levelling on uneven ground.

Accompanying this main unit are drier trailers, which are used both for collecting the material to be dealt with, and as the actual drying trays, there being a sheet steel bottom and a perforated mesh panel false bottom or drying floor on which the material to be dried is placed. These drier trailers are backed up to the furnace trailer to which they are linked by stout canvas flexible connecting ducts. Hot air from the furnace is blown between the sheet steel bottom and the false bottom and thence through the

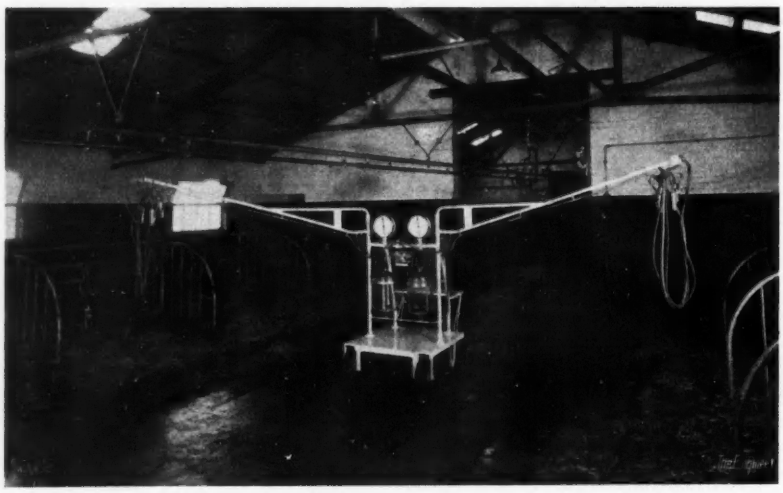


FIG. 2—RECORDING MILKING SYSTEM—ALDERSLEY

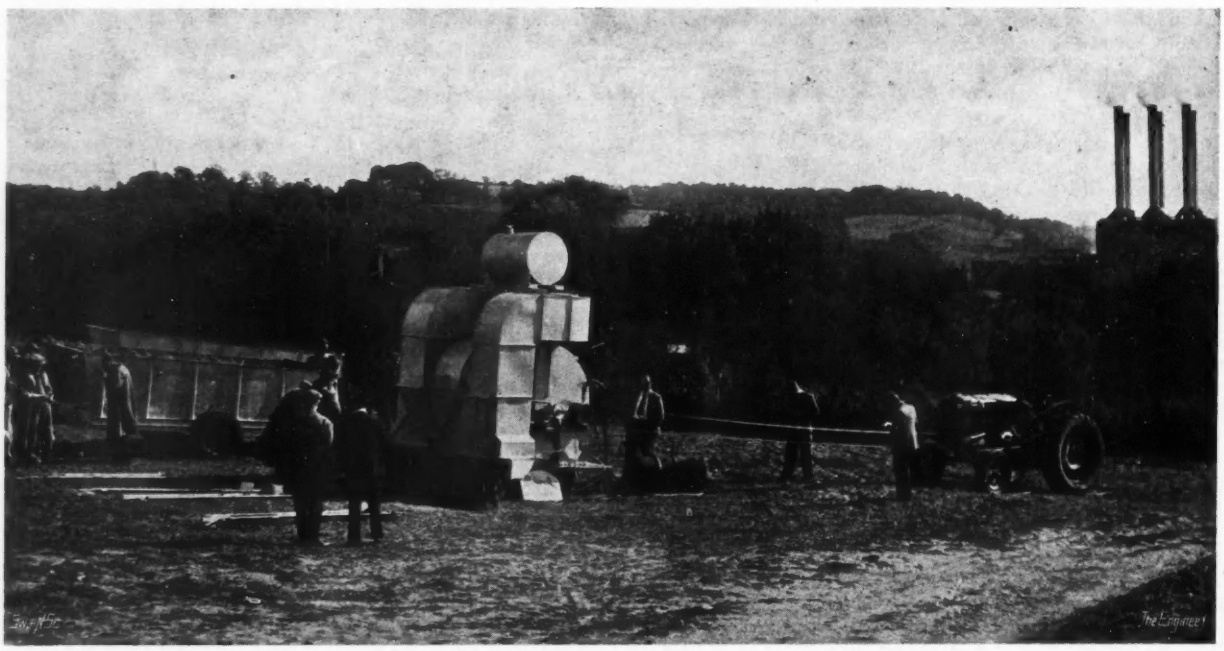


FIG. 1—"ALL-CROP" DRIER—ALDERSLEY

material loaded in the trailer. When one trailer load is dried, the hot air can be switched over by means of control slides to the second trailer, and cold air can be drawn through the former until it is effectively cooled. The warm air arising from this operation is returned to the furnace for recirculation. Heat for the drying process is supplied by an oil-fired furnace which, at average load, requires from 12 to 14 gallons of fuel oil an hour. When the equipment is in use in the field the fan is operated by tractor pulley, but when static it can be driven by a 15 h.p. motor. In addition, if any special drying is needed, a thermostat can be fitted to control the temperature at the required setting. Incidentally, the drier trailers can be equipped with a solid floor in place of the mesh panel floor and, if desired, can then be used for general farm carrying work.

Another exhibit of special interest on this stand is the Aldersley recording milking system, a photograph of which is reproduced in Fig. 2. It has been designed to enable milking to be done in the byres where cows are housed instead of in a specially constructed milking parlour. The equipment consists of a vacuum pump with a vacuum pipe-line fitted with the necessary taps, and running down the centre of a double shed, or at the back of cows in a single shed, a stainless steel milk pipe, with taps corresponding to the vacuum taps, being fitted alongside the vacuum line in the shed to convey the milk to a releaser in the adjoining dairy. The actual milking and recording apparatus is assembled as a portable unit. It is carried on a small trolley constructed of steel angles, with two fixed and one castor rubber-tyred wheels. A tubular frame mounted on the trolley carries two recorders with the necessary glass jars, master taps and milk and vacuum pipes, and two swinging arms are provided to take the teat cup clusters and milk pipes to the recorder jars. At the ends of these swinging arms the pulsators are fixed. The trolley, with its tubular frame and swinging arms, is capable of carrying two milking and recording units, and the arms are so designed that two cows can be milked at the same time, the two units being connected to the main milk and vacuum lines by a single tube to each.

Eddie T. Y. Gray

Among the general-purpose tractor trailers exhibited at the Show is that known as the "Tip-it-al," which is illustrated in Fig. 3, and which was entered as a new implement by Mr. Eddie T. Y. Gray, Fairbank Works, Mintlaw Station, Aberdeenshire. It is a two-wheeled vehicle suitable for use with several types of tractor, the body and drop-type sides being sturdily constructed from well-seasoned timber. For the chassis, heavy channel steel and other suitable sections are used, and the wheels are carried on two solid steel stub axles. To give additional strength to the wheels, the 12in brake drums are welded to the wheels. The axle brackets are wide set so that the weight is carried to the extreme axle tips, the whole axle assembly being completed by a tubular tie rod enabling the track width to be kept constant. A telescopic drawbar is provided with a safety catch, and when the drawbar is fully extended and the safety catch "on," tipping is impossible.

To tip the trailer, the tractor driver releases the safety catch, applies the brakes and reverses the tractor, which movement telescopes the drawbar. The locking bar is thus released, and a kicking bar comes into operation which gives the trailer body the initial upward thrust. Once this motion begins it is continued by the brake-locked wheels pulling the body over, and at the same time is assisted by the drawbar which pushes the body upwards until the perpendicular is reached. The axle then contacts the drawbar and acts as a safety stop. To get the trailer back to its normal position, the operation is reversed, the trailer body, locking bar and safety catch being automatically replaced.

FIG. 3—"TIP-IT-AL" TRAILER—GRAY

FIG. 4—MANURE LOADER AND SPREADER—FERGUSON

Harry Ferguson, Ltd.

New equipment designed during the past year by Harry Ferguson, Ltd., for service with its standard tractor, includes a one-man farmyard manure loader and spreader, a photograph of which is reproduced in Fig. 4. This machine, which was one of the entries for the Silver Medal Competition, consists of a loader, which is attached frontally to the tractor, and a trailer spreader. The loading fork, which has a width of 3ft 4in, can be operated from below ground level up to a height of 6ft, and, after emptying, is automatically reset by a return spring. The spreader is a two-wheeled unit, the main frame construction being of rolled channel sections. It has an overall length of 15ft 3½in, a width of 6ft 1in, and a capacity of approximately 3¼ cubic yards. When filled, the spreader is attached to the tractor by means of the Ferguson automatic hitch which is, in effect, a hook engaging with a ring or eye member fitted to the drawbar of the implement to be hauled. With the loader —which weighs 275 lb—still being carried by the tractor the spreader is hauled to the field, a mechanical latch supporting its load during transport. The conveyor running along the floor of the spreader is controlled from the tractor seat by a single lever in order that the rate of spread can be regulated. As may be seen in our engraving, the beaters, which break up the manure, and the distributor shafts are situated at the rear end of the spreader. Both the beaters and distributor shafts are provided with oil-impregnated bronze bearings, and all surfaces likely to come into contact with the manure are specially treated to prevent the possibility of corrosion.

In addition to the manure loader and spreader and the Ferguson tractors shown at Shrewsbury, the firm is exhibiting several other implements which are now in production. Among them may be mentioned a weeder consisting of seventy-one delicately sprung tines which are mounted 2½in apart on three cross members, the complete assembly being connected to the tractor by a three-point linkage. The tines are of high-carbon spring steel, are rounded and pointed, and can be moved laterally on the frame, which is of lightweight, high-strength, steel-angle construction. The working depth of the weeder is regulated by a control lever placed conveniently to the tractor seat, and the implement can be raised or lowered hydraulically by a finger-tip control lever. The working width of the weeder is 12ft 11in, but for transport the width can be reduced to 9ft 7in, as the ends of the frame may be folded by the movement of a locking bar.

Pest Control, Ltd.

An innovation in agricultural practice is the use of aircraft for crop spraying. Experiments were made more than ten years ago—mainly in the U.S.A.—with certain types of aeroplane which it was considered might be adapted to the purpose, but since the end of the war it has been found that the helicopter can be most conveniently employed, especially for liquid spraying. It is naturally a much more expensive equipment than any ground machine, but it certainly has the advantage in that the machine itself does not touch the crops or leave any tracks. This advantage is more obvious when closely inter-woven or wind-laid crops are borne in mind.

Much of the development work on aerial spraying in this country has been done by Pest Control, Ltd., Bourn, Cambridge, on whose stand at Shrewsbury there may be seen the "Spraycopter," Mark II, which is illustrated in Fig. 5. This machine, which was a Silver Medal entry, is a British-built Westland Sikorsky "S 51" helicopter, fitted with an Alvis Leonides 525 h.p. engine. The

quality of the spraying work, the makers claim, is due to the ability of the rotor to direct downwards a bell-shaped current of air into which the spray is introduced by 100 nozzles arranged on spraybooms similar to those used on ground machines. On this latest "Spraycopter" the booms are fitted aft of the main wheels, thereby, it is hoped, providing better coverage when dealing with high-growing crops. The booms, it should be added, extend 17ft on each side of the aircraft. Helicopters hitherto equipped by Pest Control, Ltd., for spraying have been provided with a pump, driven by a 3 h.p. auxiliary engine, for applying pressure to the spray, but a departure from that practice has now been made and on the new "Spraycopter" a compressed air system is employed. It was found that highly toxic chemicals used for spraying tended to shorten the life of the pump owing to corrosion, and, moreover, in tropical countries, low atmospheric pressure often reduced the efficiency of the auxiliary engine. The spray chemical is carried in a light alloy tank of 70 gallons capacity, and the compressed air is stored in six bottles mounted on an outrigger in the nose of the aircraft. Incidentally, in that position, the bottles act as ballast to balance the weight of the spraybooms. The bottles can be replenished, by means of a pipe with a bayonet fitting, from a supply carried by a ground tanker lorry which also accommodates spray chemicals and 200 gallons of aviation fuel. Though it is normally a three-seater aircraft, the "Spraycopter" takes only the pilot when the spraying equipment is attached, and he is assisted in the spraying operations by two or three flag-men on the ground with whom he communicates by radio. The company, which is now operating three of these machines, says that the working speed varies between 12 miles an hour for tall crops and 30 miles an hour for field crops, and claims also that they can be used in steady winds of up to 30 miles an hour. Development work is now proceeding on a three-rotored helicopter—the "Spraying Mantis"—which will provide a heavier load-carrying capacity than the "Spraycopter."

FIG. 5—"SPRAYCOPTER," MARK II—PEST CONTROL

Pest Control, Ltd., has also introduced this year a low-volume spraying machine, known as "The Weedmaster." It has been designed primarily for use with "Phenoxylene," though it is considered to be quite suitable for applying other weed-killers of the plant hormone type. The machine is now being produced for fitment to Fordson Major or Ferguson tractors. It comprises two tanks of all-welded construction, each of 22½ gallons capacity. In the filling hole of each tank a filter is provided. A rotary pump, having a capacity of 3 gallons per minute at a pressure of 40 lb per square inch with a shaft speed of 500 r.p.m., is attached to the tractor by means of a bracket bolted to the axle housing, and the drive is taken direct from the power shaft of the tractor through a flexible coupling. The 14ft sprayboom, which is in two equal sections, is adjustable in height between 16in and 30in, and "Teejet" nozzles, each having an individual filter and fitted with replaceable nozzle tips, are spaced at intervals of 18in. Controls are situated within easy reach of the operator, and when the levers are depressed the sprayboom is automatically connected with the suction side of the pump, thereby clearing surplus liquid and preventing nozzle drip. When not in use, the sprayboom can be mechanically retracted to the vertical position, as illustrated by the engraving, Fig. 6.

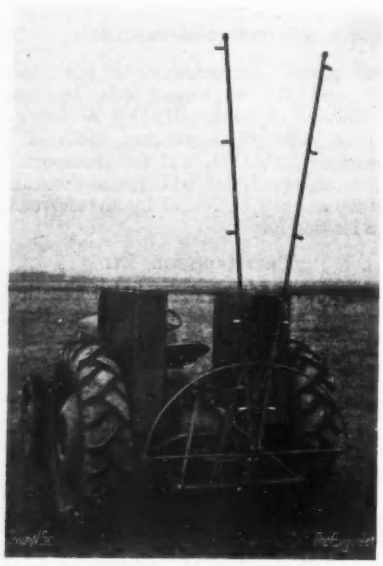


FIG. 6—"WEEDMASTER" LOW-VOLUME SPRAYER—PEST CONTROL

(To be continued)

North of Scotland Hydro-Electric Board: Annual Report

THE annual report of the North of Scotland Hydro-Electric Board for the year 1948 has recently been published. Considerable progress was made in the Board's work during the year, and the programme for the generation, transmission and distribution of electricity on which work is being carried out at present, has a total value of nearly £100 million. Nearly 7000 workers were directly engaged on construction work at the end of 1948.

The first of the new hydro-electric schemes came into operation in December, 1948, one at Morar, Inverness-shire, and the other at Lochalsh, Ross-shire, and a further twelve hydro-electric stations with a total capacity of 423,000kW were under construction by the end of 1948. Thirty-two turbines and twenty-six alternators for these stations are being built in Scotland.

Hydro-Electric Construction.—Hydro-electric schemes, which were either being surveyed, promoted or constructed during 1948, will have an aggregate capacity of about 800,000kW, with an estimated annual output of about 2200 million units, which is equivalent to over 50 per cent of the present consumption of electricity in the whole of Scotland. Of these schemes, nineteen have already been published with a total capacity of approximately 630,000kW and an annual output of almost 1700 million units.

Seven constructional schemes for the generation of electricity were published last year. Four of these were large schemes—Garry, Moriston, Lawers and Glascarnoch-Luichart-Torr Achilty—with an annual output of 735 million units. Preparatory work on these schemes has already been started. The other three schemes were the Allt-na-Lairige in Glen Fyne, a scheme to give a local supply in the Ullapool district of Ross-shire and an extension to the Loch Sloy scheme.

Work went on steadily during the year at at the large schemes at Sloy, Tummel-Garry, Fannich and Affric, and construction began on the Shira scheme. These schemes will have an aggregate capacity of 412,000kW, and an annual output of about 810 million kWh. Work proceeded also on the Cowal scheme and on three smaller schemes serving isolated areas—Gairloch (Ross-shire), Lussa (Kintyre) and Storr Lochs (Skye).

Operation and Distribution.—As a result of the Electricity Act, 1947, from April 1, 1948, the Board became responsible for generation, transmission and distribution in an area of approximately 21,600 square miles. It now operates nine hydro-electric stations, six steam stations and thirty-two diesel stations, with a total capacity of 250,548kW. During the year about 45,000 people in the Board's area were given electricity for the first time.

The Board are constructing a "Highland Grid" to interconnect the major generating stations, and part of this work will bring increased power supply to Aberdeen and Dundee areas. The grid will link with the British Electricity Authority's grid at two places.

Research.—Research work undertaken by the Board includes hydraulic research and model tests on dams, waterways and fish passes, work on electrification of highland agriculture, and geological investigations. Fishery research is also being carried out on the Board's reservoirs, and rainfall and river flow statistics are being recorded.

Following tests carried out on two exposed hill tops in the Orkney Islands, the Board have decided to build a windmill in Orkney for the generation of electricity. It will have a diameter of about 60 ft across the blades, and the output will be about 100kW.

Tariffs and Finance.—The Board's trading account showed a deficit of £35,635 for the year, as compared with a deficit of £38,710 at the end of 1947. When the Board took over certain undertakings, such as at Aberdeen and Dundee on April 1, 1948, the existing tariff had become insufficient to meet the rising costs. An adjustment was made towards the end of the year, and it is hoped that in 1949 the new tariff will suffice to offset the increased costs of labour and materials.

FILMS ON COPPER.—The Northern Rhodesian Copper Companies have sponsored two new 16mm sound films, one on copper mining, and the other on copper ore dressing, smelting and refining, as carried out in Northern Rhodesia. The films will be distributed on loan to schools, colleges and organisations likely to be interested, by the Copper Development Association. Requests should be sent to the Association at Grand Buildings, Trafalgar Square, London, W.C.2. Later in the year a 16mm sound film in colour illustrating life and work in the Northern Rhodesian Copper Belt will become available.

The Institution of Civil Engineers' Conversazione

THE annual conversazione of the Institution of Civil Engineers was held on the evening of Thursday, June 30th. The programme included the reception of a large number of members and guests by the President, Sir Jonathan Davidson, and Lady Davidson, and the Council of the Institution in the Great Hall. Music was provided by the Central Band of the Royal Air Force and a violin recital was given by Miss Olive Zorian. As is usual at this function, a display of models of engineering and scientific apparatus was on view in the library.

Display of Models

Models of Colonial Interest.—In view of the fact that the conversazione took place during Colonial Month, a number of exhibits of colonial interest were included in the display. A selection of specimens of colonial timbers of established commercial value was on view, and the use of these timbers in industry was indicated. These exhibits were arranged by the Forest Products Research Laboratory. Various technical details concerned with the production of maps from aerial photographs were displayed by the Directorate of Colonial Surveys.

The Crown Agents for the Colonies exhibited a model of the Nigerian Government's suction dredger, "Oyo," of 4000 ton's capacity, which was completed in 1948 and was designed for working on exposed sand bars. A planning model of a semi-outdoor power station at Cyprus was exhibited by C. H. Pickworth. The capacity of the completed station will be 70,000kW, and it has been designed to supply power through a new transmission system, which will eventually cover the whole island. It is hoped that by 1951 the first stage of the new power scheme for the island will be complete, thus relieving the existing overloaded power stations and enabling obsolete plant to shut down.

Exhibits of General Interest.—Apart from the exhibits mentioned above, a large number of models were on view, covering a variety of subjects with a wide appeal to engineers. In addition, the display included the winning entry of the Charles Hawksley Prize Competition, 1949 (P. B. Mitchell), a selection from a collection of prints made by John Rennie and his son, George, and various similar items of historical and general interest.

The work of the Road Research Laboratory in the field of road safety and traffic-flow studies was illustrated by several exhibits. They were concerned particularly with the selection of the most conspicuous type of pedestrian crossing and with methods of obtaining traffic flow data. Research in soil mechanics was exemplified by petrified model casts, exhibited by Dr. Fordham and Mr. Williams, showing the disturbances induced in granular and cohesive materials due to the overrunning of a pole placed in them. A cast giving an interesting confirmation of the Friction-Circle method of analysis for non-cohesive material was included with these exhibits.

An exhibit by M. K. Rice-Oxley was the Arithmometer or calculating machine first patented by M. Thomas (de Colmar) in 1820. Primarily intended for addition, subtraction, multiplication and division of figures, it can also be used for the extraction of square roots. Its application to the construction of life contingency tables was described in 1874 and, in general, it may be said to be an early example of the calculating machine as used for many purposes.

A model of the Mersey Docks and Harbour Board's new diesel-electric grab hopper dredgers, "Mersey No. 26" and "Mersey No. 27." was on view. The construction of these vessels was described in The Engineer of December 24, 1948. The British Electricity Authority, Eastern Division, supplied an interesting model, showing the lay-out of the new base-load station, Cliff Quay, at Ipswich.

Structural Analysis.—Methods of model-analysis of engineering structures, which have been used in the design of the continuous welded steel frameworks of the Steel Company of Wales' new mills at Port Talbot, were illustrated in an exhibit due to W. S. Atkins. The principle of the apparatus is that of the well-known Beggs method, but following upon the work of Professor A. J. S. Pippard, large displacements are used, which greatly facilitate the experimental technique. The method is applicable to the analysis of highly redundant "fully-rigid" building frames and is particularly useful in cases where the frame is of non-uniform section and many loading cases have to be considered.

Several other examples of stress analysis were included in the display. The National Physical Laboratory exhibited models illustrating the photo-elastic method of stress analysis and a model illustrating the action of a ball bearing. The analysis of a steel truss railway bridge, with electrical resistance strain gauges was also shown by the laboratory. Gauges were fixed to eight tie-bars of the bridge model, and meters indicated the variation of load as a locomotive passed over the bridge.

A portable vibrating-wire strain gauge unit was exhibited by the Building Research Station. An interesting point with this unit was that the gauge itself was broken down into two separate components, namely, the vibrating wire and the energising and pick-up head. Only the wire needs to be installed at each measuring point in a structure and one head will then indicate the strain at any number of points, thus effecting an economical method of testing.

In use, the head is brought close to each wire in turn. It plucks the wire electro-magnetically and transmits the vibrations electrically to the measuring set, in which a standard wire is caused to vibrate. Both vibrations are transmitted to headphones and are tuned to the same frequency by the method of beats, the frequency of vibration of the standard wire being adjusted as necessary. By applying an initially determined calibration factor to the change in frequency of the wire from its frequency when originally installed at the measuring point, a measure of the strain in the steel member at that point is obtained.

Structural Techniques.—Two interesting methods of construction were shown, the first exhibited by J. H. de W. Waller and K. Billig, and the second by G. P. Manning.

The first exhibit consisted of models of corrugated concrete shell roofs. These roofs were of catenarian shape in the cross direction and were corrugated longitudinally. Due to the catenarian form they are true arches and all stresses due to dead weight are purely compressive. The corrugations make the structure rigid and resistant to wind loads. An economical technique of construction has been developed for this type of structure.

The model of G. P. Manning was the structural skeleton of an aluminium domed roof suitable for spans up to 600ft in diameter. All the main members of the roof are of the same cross-section, and are placed as great circles of the dome. There is a tenoned joint at each intersection of these members. The finished roof is very light, a roof of 82ft 6in in diameter weighing about 4½ tons with a single sheet (16 G) covering, corresponding to under 2 lb per square foot of plan area. Various advantages, such as resistance to corrosion and elimination of fire hazard (the roof will not spark), are claimed for this type of structure.

Electrical Exhibits.—J. W. Dalton and W. B. Whitney exhibited a magnetic "recollectograph." This device secures and retains magnetic records of any sudden transient event and also "recollects" any change of conditions during a short period immediately before the event, without need of providing lengthy continuously moving tape, paper or film. The machine was designed to obtain records of chance faults in electric networks but has many other uses in recording sudden events, the exact time of occurrence of which cannot be predicted, and which only occupy periods of the order of a second or less.

The Research Laboratory of the General Electric Company exhibited samples of phosphorescent and fluorescent materials and a technique of welding at room temperature by pressure only—cold pressure welding—developed at the laboratory.

Canadian Engineering News

Lachine Canal Tunnels

The Federal Government has announced the completion of negotiations with the City of Montreal for the construction of two vehicular tunnels under the Lachine Canal at a cost of approximately 11,000,000 dollars. The two tunnels, one of which will be started this year, will connect the heart of the city with Verdun, Ville la Salle and other municipalities and wards lying south of the canal. The plans for the first tunnel provide for two separate roadways, 24½ft wide, with a vertical clearance of 14ft in the tunnel section. An 8ft pavement is provided for pedestrian traffic. The tunnel itself will be 485ft long, and the overall length including approaches will be 2500ft. The construction will be carried out by open-cut methods, the bulk of the excavation being in solid rock. The second project, known as the Atwater Avenue tunnel, will present engineering difficulties of some magnitude, since the natural rock surface is overlaid by some 50ft of glacial silt in the area where the tunnel is to be built.

New Steel Pipe Mill

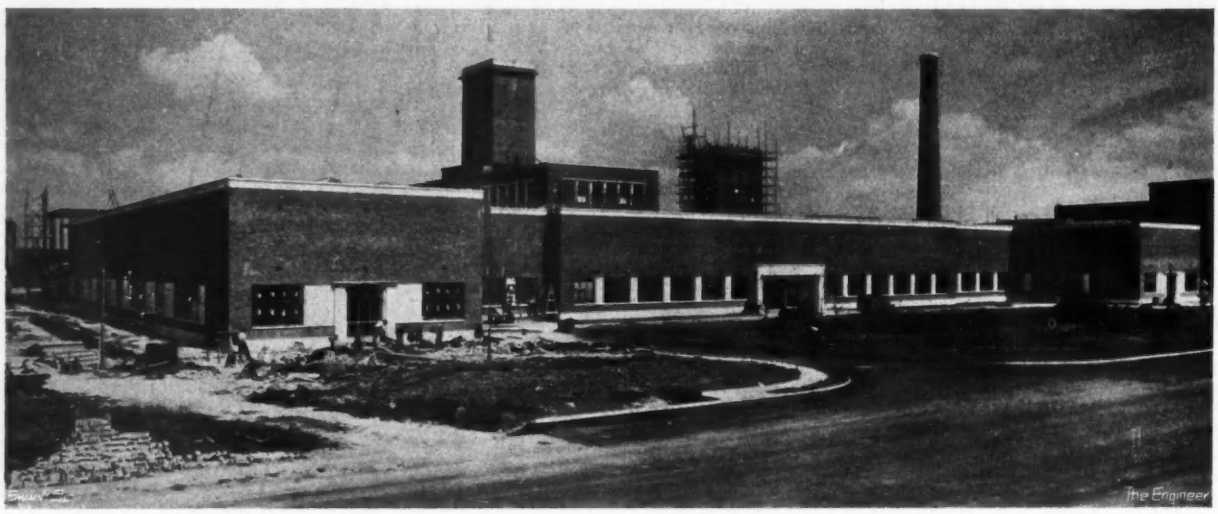
It has been announced by Page-Hersey Tube, Limited, that that firm will have a new steel pipe mill in operation at Welland Ontario, by early autumn. The new mill will represent an investment of approximately 5,000,000 dollars and will make electrical resistance welded pipe, not formerly manufactured in Canada, by a cold expansion process. Early erection of the mill was accelerated as a result of Canada's increasing needs for oil industry supplies, and an order for 457 miles of 16in pipe for the Imperial Oil Company's projected Edmonton-Regina pipe-line. The building which will house the new equipment is 95 per cent finished and foundations for machines are 30 per cent complete. Altogether the Imperial Oil Company has placed orders exceeding 9,000,000 dollars for its proposed pipe-line between Edmonton, Alberta and Regina, Saskatchewan. Roughly 67,000 tons of special steel plate have been ordered from the Steel Company of Canada, Ltd., at Hamilton, Ontario, which will make the steel and roll it into plate.

Canso Bridge Borings

The Federal Government has approved a contract to Foundation Maritime, Ltd., of Halifax, to make test borings in the Strait of Canso, preliminary to building the bridge joining Cape Breton Island with the mainland. Conditions in the Strait of Canso are difficult, there being strong tidal currents and an average low-tide depth of 185ft. The initial project will involve lowering approximately 190ft of casing, weighing about 40 tons, and the erection of a working platform on which to mount the drilling machinery. The drilling will be carried out inside the casings to a depth of 10ft into the bed-rock, to ensure a foundation suitable for the eight piers of the bridge span. The bridge will be a low-level railway and vehicular structure more than 3000ft long, between Cape Porcupine on the Nova Scotia mainland and Balache Point on Cape Breton. It will have a clearance of 14ft at high tide and a vertical lift span close to the Cape Breton shore, giving a 156ft clearance for shipping.

The "Hot" Laboratory at Harwell

THE Ministry of Supply announced recently that one wing of the new radiochemical laboratory (the so-called "hot" laboratory) at the Atomic Energy Research Establishment, Harwell, was ready for use. Brief reference to this laboratory in an earlier stage of its construction was included in the general description of the Research Establishment published in THE ENGINEER of July 30th, 1948, page 116.



RADIOCHEMICAL LABORATORY AT HARWELL

It will be recalled that the radiochemical laboratory is intended primarily for research on the chemical problems of separating the fissile element plutonium from uranium rods that have been irradiated in one of the atomic piles. The laboratory will also be used for other chemical work with radioactive materials, including the separation of radio isotopes produced in "B.E.P.O." (British Experimental Pile) and the processing of materials that have been irradiated in the pile. Inevitably the problems inherent in the work of separating these highly radioactive fission products are complicated by the elaborate precautions that are necessary to preserve the health and safety of the laboratory workers. Accordingly, the laboratory is designed to provide optimum facilities for working with "hot" (radioactive) materials, and the health monitoring safeguards are based on a comprehensive system for the control of any radioactive material in dust, gases or effluent.

A general view of the laboratory building is reproduced above. In the centre of the ground floor is the administrative block, which consists of offices, laboratories, stores and workshops. The "hot" laboratories, with their special ventilation arrangements, are housed in the two wings, which are isolated from the administrative block by air locks. As indicated in our first illustration, the whole of the first floor of the building is windowless. This portion of the building, together with the raised block in the centre, contains the main services and the air ducts, forming part of the special ventilating system which exhausts through the square central tower. As far as possible therefore the services and the ventilation ducting are concentrated in the first floor and are segregated from the rest of the building, to simplify the task of maintenance.

To give an impression of the arrangement of these services, we reproduce on the opposite page a photograph giving a general view of part of the first floor. Grouped together in the centre are the distribution boards and switchgear for some of the electrical services. The illustration also shows two of the 6ft square ducts which form part of the ventilating system.

Filtered dust-free air is admitted into the building and distributed throughout the hot laboratory and exhausted at a rate which is sufficient to extract any radioactive dust and fumes. The maximum flow of atmospheric air is approximately 360,000 cubic feet per minute, which is enough to provide any laboratory room with 120 complete changes of air per hour. Under normal conditions, however, it is not expected that the rate will exceed forty changes per hour, and the system therefore carries a useful reserve of capacity for emergencies. Any active solids removed by the ventilating air are retained by precipitators before the air is discharged through the central square tower. In parenthesis, it is stated that all effluent discharged through the laboratory drainage systems is similarly segregated and monitored before final disposal.

The general arrangement of a typical laboratory room is shown in one of the photographs reproduced herewith. In the background is a fume cupboard lined with interlocking lead bricks for work with radioactive materials, with provision for the processes to be controlled from outside the cupboard. On the extreme left of the illustration is a row of glass-fronted store cupboards above a lead-lined storage space. In the foreground is a bench for general work and in the ceiling above the bench is the special air inlet. Suspended centrally from the ceiling, beyond the air inlet, is a cylindrical ionisation chamber and, on the wall above the fume cupboard is an indicator for the measurement of radiation. Similar indicators, flush-mounted on the wall above the store cupboards, can be seen on the extreme left of the illustration.

Extraction of radioactive particles is but a second line of defence and the laboratories are so designed as to minimise the ingress of dust. Since the ventilation system provides a flow of filtered air, the double glass window is required for natural lighting only and is hermetically sealed. With the object of eliminating "dust-traps" the inside of the window presents a single plane surface flush with the wall; the angles between the walls, floor and

A TYPICAL LABORATORY ROOM

ceiling are rounded, and the two lighting fittings are recessed behind glass panels, flush with the ceiling.

Various other precautions are taken against radioactive hazards. All laboratories are centrally. Changing-rooms and showers are provided for staff entering or leaving "hot" areas and foot-operated wash-basins are situated outside each laboratory group. The risk of contamination from the hands is still further

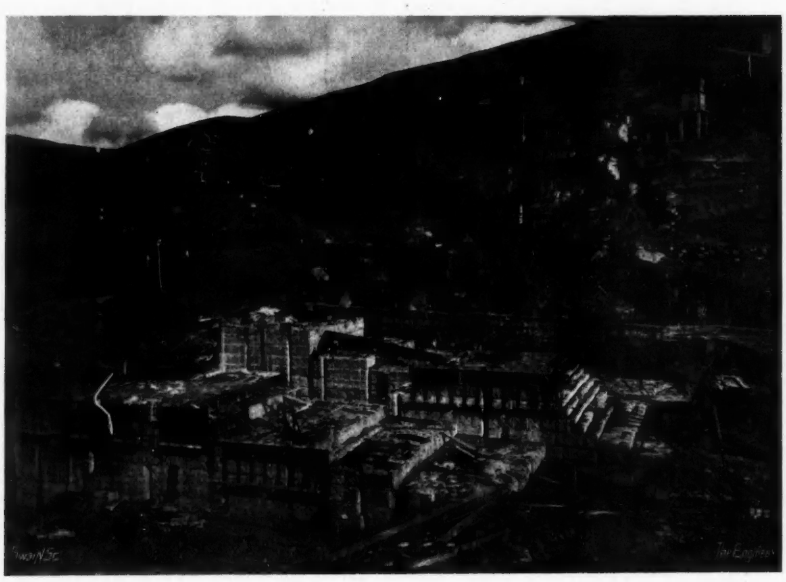
SERVICES AND VENTILATION DUCTS ON FIRST FLOOR

continuously monitored, or checked for radioactivity, so that the staff may know the amount of radiation to which they are exposed. Alarms for radioactivity risks are provided, together with fire alarms, throughout the building and the operation of any alarm signal is recorded reduced by the provision of photo-electric cells to operate doors in "hot" area corridors. Equipment for monitoring hands, clothing and body, is provided at all washing places and there is an automatic monitoring system to check people leaving the building.

Claerwen Dam

ON Tuesday, June 28th, members of the Midlands Association of the Institution of Civil Engineers were able to visit the site of the Claerwen Dam in the Claerwen Valley, Radnorshire. The visit had been arranged by the party was entertained to tea at the Elan Valley Hotel by the Birmingham Water Department.

The Claerwen Dam is a mass concrete structure, which will have a length of 1066ft at



CLAERWEN DAM, APRIL 1949

permission of the Birmingham Water Department, for whom the dam is being built. The motor-coach journey to the dam site commenced at 8.30 a.m. from the James Watt Memorial Institute, Birmingham, the route passing through very pleasant countryside by way of Kidderminster, Bewdley and Ludlow, and thence through the village of Rhayader to the Elan Valley. After visiting the site, top water level and a crest height of 182ft above the stream bed level when completed. A description of the dam and its significance in relation to the water supply system of Birmingham was published in THE ENGINEER of December 6, 1946. A roadway will be constructed across the top of the dam, the centre line of which follows a gentle curve, this shape giving a more harmonious appearance than a straight structure. The upstream face of the dam is to be lined with blue brick, except for the top 40ft, which will be lined with masonry; the downstream side will be faced with masonry throughout. At the present time about one-tenth of the concrete has been placed and it is estimated that the dam will be completed in about three years' time. A recent progress photograph of the dam is shown in the accompanying illustration. The channel which has been built to carry the stream flow during construction can be seen running across the centre of this illustration.

Uncrushed stone is supplied to the site from a nearby quarry and is delivered into a crushing and washing plant situated about 100 yards downstream of the dam centre-line. The graded aggregates are transported on a conveyor belt from the stockpiles of the crushing plant to the storage hoppers of a 3 cubic yard Winget concrete mixer, and cement is fed to this mixer on a separate conveyor belt from a bulk cement store. The mixer is a tilting-drum weigh-batching machine with a rated output of 120 cubic yards per hour; it is driven by a 40 h.p. electric motor. The mixed concrete is discharged into skips, which run on tracks from the mixer to a position underneath two cableways, which span the entire length of the dam. The skips are then hoisted by the cableways and transported to any desired position of placing.

The concrete mix is of some interest, a 7 : 1 ratio of aggregate to cement being used with a special low-heat Portland cement and four grades of aggregate, namely, 6in, 3in, 1½in, and fines. The concrete is poured in 4ft lifts and in blocks about 46ft long. Each of these blocks stretches across the entire width of the dam, there being twenty-three blocks in all. An interval of six weeks is allowed between placing adjacent blocks. This time interval allows contraction of the original block to have taken place, and subsequent contraction of the adjacent block forms a transverse vertical joint sufficiently large to accommodate thermal movements in the completed structure. A corrugated vertical strip of copper is placed along each of these joints near the upstream face of the dam to ensure impermeability.

Visitors to the site were particularly interested in a one-forty-eighth scale hydraulic model of the dam, which has been used to solve various design problems. In particular, the shape of the spill-weir channels was modified slightly as a result of tests with the model, the corners, where the two side channels join the central channel, which will extend downstream from the dam for about 360ft, being slightly enlarged. The consulting engineers for the Claerwen Dam are Sir William Halcrow and Partners, and the contractors are Edmund Nuttall, Sons, and Co., Ltd.

VISIT OF STUDENTS FROM NORGES TEKNISKE HOYSKOLE.—A party of twenty-four students from Norges Tekniske Hoyskole, Trondheim (The Technical University of Norway), under the leadership of Professor Are Hagemann, on a short visit to this country, recently spent a day at the B.T.-H. 123-acre Rugby Works as guests of the British Thomson-Houston Company. In addition to inspecting the equipment and work in progress in the turbine, heavy electrical plant, transformer, motor, control gear and industrial electronics factories, the visitors toured the Mazda Lamp Works and the Research Laboratory. Among the many items of plant in manufacture which were seen were two 35,000-kVA, 500 r.p.m. horizontal water-wheel alternators for the Abjora Power Station of the Vestfold Power Supply Company, Norway.

COAL CONSERVATION AND UTILISATION.—We have received from Mr. W. Wakefield Adam, M.I.Mech.E., M.Inst.F., a booklet containing his recent lecture to the Institute of Export, Birmingham, entitled "Coal Conservation and Coal Utilisation Necessary for Britain's Future Welfare." Mr. Adam indicates how, by reducing the waste of coal, and by improved utilisation, this precious mineral can be made available for possibly several centuries yet. The booklet may be obtained from Mr. Adam, price 6d., at Kings Court, 48, Broadway, London, S.W.1.

A Railway Plan for London

PROPOSALS for extensive improvements and additions to London's railway system are made in a report to the Minister of Transport, by a Working Party of the Railway and London Transport Executives, set up by the British Transport Commission.

The plans take into consideration the recommendations of the Railway (London Plan) Committee, under the chairmanship of Sir Charles Inglis, Professor of Mechanical Science at Cambridge, published in 1946 and 1948.

Recommended as works of first priority are :—

Four completely new tubes of a total length of 49¼ miles and costing £114,000,000, with extensive electrification of the existing steam surface lines to be joined to the new tubes.

Three major schemes for the electrification of steam lines from Marylebone, Fenchurch Street and Liverpool Street, and the completion of the 1935/40 programme of new railway works for London, including the Alexandra Palace Line electrification, extensions of the Northern Line tube, four-tracking of sections of the Metropolitan Line, and further Metropolitan Line electrification.

Improvements of Southern Region services, particularly in South-East London, either by double-decker trains or by increasing trains from eight to ten coaches.

The effect of the above proposals is that, in addition to the new tubes, all steam suburban services now running from Liverpool Street, Marylebone, Fenchurch Street, Euston, King's Cross and St. Pancras would be electrified.

The Report is a comprehensive review of railway traffic requirements in relation to the planning of London, with far-reaching recommendations for new railways, designed to relieve overcrowding on existing routes, to provide new lines for areas which are under-served, and additional railway facilities to meet the replanning of London within the Greater London area. The first concern of the Working Party, it is stated, has been to consider the urgent needs of the hundreds of thousands who must travel daily between home and workplace. At the same time it has paid regard to the broad conceptions of future development contained in the County of London Plan, the City of London Plan, and the Greater London Plan, and the proposals envisage the removal of Blackfriars railway bridge and Holborn Viaduct terminus to meet the requirements of redevelopment of the South Bank of the Thames and reconstruction in the City of London.

Because of the magnitude of the proposals, the recommendations are divided into two parts : works of first priority which should be tackled as soon as possible, and works of lower priority, which could not be tackled for many years to come. It is suggested that a Government decision in principle should be given on works shown under "first priority," so that decisions may be reached as to which works in this category should be started first and detailed plans for them put in hand by the Railway and London Transport Executives.

New Tube Railways

The new first priority tube railways involve the construction of 49¼ route miles of railway in tube, at an estimated cost of £114,000,000. The associated electrification schemes and improvements of existing surface lines are estimated to cost £100,000,000.

Of two types of new tubes proposed, some would be for main line size rolling stock, making few stops in the central area, having big seating capacity and providing up to twenty-five trains an hour to the outer suburban areas. Others with London Transport type tube rolling stock, would have frequent stops in the central area, ample standing capacity and provide up to forty trains per hour in the inner suburban areas. The tunnels for main line size tubes would be 17ft in diameter and for London Transport tube size 12ft in diameter.

The following new tubes and extensions are recommended as of "first priority" :

Route "*A*."—A main line tube to replace rail passenger and freight services at present using Blackfriars railway bridge, the removal of which the Report presumes on planning grounds. The tunnel sections of this tube would commence from two northern points, West Hampstead and Finsbury Park, joining up near Euston. From Euston the tube would continue via Russell Square, Chancery Lane, Ludgate Circus, to Elephant and Castle and join the Southern Region lines near Loughborough Junction. From West Hampstead northwards the tube trains would run over the present London Midland Region suburban line, which would be electrified to Elstree, Radlett and St. Albans.

From Finsbury Park northwards the tube trains would run over the Eastern Region (present King's Cross) line, which would be electrified to Hitchin via two routes : New Barnet, Potters Bar, and Hatfield, and Enfield Chase and Hertford.

Beyond Loughborough Junction in the south, the trains would incorporate the service now terminating at Holborn and would proceed along the Chatham main line via Beckenham Junction ; along the Catford Loop via Nunhead, and over the Tooting, Wimbledon and Sutton Line.

Route "*B*."—A new tunnel route for freight traffic only, to run beneath the Thames, between Canning Town in the north and Blackheath in the south ; it would link the main lines north of the river with the Southern Region lines at Hither Green. This new tunnel route would carry freight traffic, which at present uses Blackfriars railway bridge, and give a new connection with the Great Eastern section.

Route "*C*."—A new inner suburban tube from the Tottenham-Edmonton area with stations at Manor House, Finsbury Park, King's Cross, Euston, Oxford Circus, Green Park, Victoria, Vauxhall, Stockwell, Brixton, Streatham Hill, Streatham, Norbury and on to East Croydon. In the north, passengers would have interchange facilities with electrified Eastern Region lines to Enfield Town, Bishop's Stortford, Harlow New Town, and Chingford.

This tube, of London Transport size, would give a new in-town route between Victoria, Euston, and King's Cross, and link with the Bakerloo Line at Oxford Circus. In addition to giving much needed facilities between Tottenham and Edmonton and sections of the West End, and relieve the Piccadilly Line north of King's Cross, this line would also relieve King's Cross, the Victoria to Balham Southern Region Line and South London road services.

Route "*D*."—A new tube, of which the tunnel section would commence at Hackney Downs, with stations at Liverpool Street, Bank, Ludgate Circus, Aldwych, Trafalgar Square, and Victoria. North of Hackney Downs the tube trains will proceed by two electrified routes to Seven Sisters, Bruce Grove (Tottenham), Edmonton, and Enfield Town, and to Clapton, Hoe Street, Wood Street (Walthamstow) and Chingford.

This line, which is in the lower priority category, will provide a new connection between the West End and City through the Bank—Fleet Street—Trafalgar Square.

Plans are already in hand for the commencement early next year of an extension of the Bakerloo Line from Elephant and Castle to Camberwell. Early completion is recommended of the pre-war plans for the extension of the Northern Line tube from Highgate to Alexandra Palace, from Mill Hill East to Edgware, and from Edgware to Bushey Heath, and for the four-tracking of the Metropolitan Line from Harrow to Rickmansworth.

Major Main Line Electrifications

From Marylebone the Report recommends the electrification of the suburban service on the Tring, Berkhamsted and Watford lines. This line would be diverted through a new connection at Kenton, so as to run over electrified tracks into Marylebone. The present Aylesbury line services via Rickmansworth and Harrow-on-the-Hill into Marylebone, and the Eastern Region High Wycombe—Beaconsfield—Denham services into Marylebone should also be electrified.

Thus Marylebone will become the terminal of the three electrified lines and the provision of interchange facilities with the Circle line at Marylebone would require consideration.

The electrification and widening of London, Tilbury and Southend Line from Shoeburyness into Fenchurch Street, with main line size rolling stock, and the doubling of the Ockendon Branch is proposed to give improved services in South Essex. A possible western extension of this line through the City in tube of main line size falls into lower priority.

It is also proposed to electrify the Eastern Region Cambridge Line from Liverpool Street via Waltham Cross, Broxbourne to Bishop's Stortford, including the Churchbury Loop, with main line size rolling stock.

On the Southern Region the report recommends the introduction of double-decker trains or the lengthening of trains, at an early date, from eight to ten cars, priority being given to the South-Eastern suburban lines. A full-size test of double-decker trains for these lines should be arranged as a possible alternative, and this has been put in hand by the Railway Executive.

Also recommended for first priority are two widenings of the Southern Region lines from Norwood Junction to Purley and from Bickley to Swanley Junction.

Other Works

Tentative proposals for works of lower priority also recommended would necessarily be undertaken after the schemes mentioned above. The whole of the works proposed would take, at a minimum, twenty to thirty years to complete. These works of lower priority which include four further new tubes and extensions of earlier works, include the following :—

(1) Possible western extension of the first priority tube beyond Victoria.

(2) A new small-size tube paralleling the Northern Line between Kennington and South Wimbledon, with branches to Chessington South and North Cheam.

(3) A new tube of main line size, linking Neasden with the Tring, Aylesbury, and High Wycombe lines from Marylebone and running via Marylebone, Marble Arch, Trafalgar Square, Bank and Fenchurch Street, to Hither Green and thence via the Dartford Loop to Gillingham and via the main line to Sevenoaks.

(4) A westward extension of the London, Tilbury and Southend service in tube of main line size via Bank, Southwark Street, and Waterloo, to link with Southern Region suburban services on the western section.

(5) Alternative schemes for a new small-size tube extending the Northern City Line southwards from Moorgate, either in the direction of Crystal Palace or through New Cross to Woolwich, with probably a crossover connection to Dagenham.

(6) A new small-size tube extending the Holborn-Aldwych Line to Waterloo.

While the Working Party presumed the removal of Blackfriars railway bridge and the surface railway viaducts to Holborn (including the bridge over Ludgate Hill) and south of the river as an important contribution to the replanning of the City of London and the development of the South Bank, it felt bound to recommend that, from the point of view of transport, the removal of Charing Cross and Cannon Street railway bridges would not be justified.

High-Voltage Research and Development in the British Cable-making Industry*

Present Position

The methods for the examination of materials developed for solid-type cables have paved the way for the selection and economic use of materials for employment in cables of the alternative types, in which the primary advantage arises from reduced thickness of dielectric for a given voltage. Further advantage is being looked for from the use of very thin papers in the region of highest stress, combined with smoothing or screening of the conductor, which have already been employed to some extent.

Great improvements have taken place in recent years in the reliability of lead sheathing, and improved sheathing technique, combined with the choice of lead or a suitable alloy according to the conditions of installation, may confidently be expected to give freedom from lead sheath troubles.

Extensive development work is proceeding on the use of aluminium as a substitute for lead in cable sheathing and is to be encouraged in view of the rapidly approaching exhaustion of the world's known lead supplies. Cables can now be supplied with an aluminium sheath, consisting of either a tube drawn down to a close fit or a welded strip. Co-operative work is going on in connection with extrusion. Deputations have been sent to Germany to examine the equipment developed there. Co-operative work is also proceeding on the corrosion aspect. Satisfactory progress has been made with the problems entailed in dealing with the aluminium cable sheath where the cable is connected to accessories, and a plumbing technique has been evolved.

From the point of view of economy of steel, it is to be noted that, while most users still appear to prefer buried cables to be armoured where possible, the experience with large quantities of 66-kV single-core solid-type cable has shown that armouring is not always essential.

While the problems of the design of efficient jointing and terminating accessories have become more acute with increasing voltages, it can be said that accessory design has been able to keep pace with cable operation requirements. In some cases, modifications of design have been made to meet impulse-voltage test specifications.

An interesting, but not yet extensive, application of ceramic technique is the use of a high-resistance conducting glaze on the porcelain insulators for outdoor terminations, thus controlling the distribution of surface potential and reducing the tendency to flash over under bad atmospheric conditions.

Regarding the solid-type cable, it would not appear that any further outstanding completely new development, apart from sheathing, is now to be expected, and further progress is to be looked for rather in the domain of standardisation.

One matter on which some divergence of practice remains may be mentioned. While the large majority of high-voltage solid-type cables continue to be impregnated with fluid compounds, provision against migration of compound will be necessary. Generally this is done by introducing resistance to compound flow at joints in one or more of several ways which have proved satisfactory. In addition, limitation of static head is achieved by the introduction at suitable intervals of barrier joints, the more commonly used type having a barrier plate carrying a bushing insulator for each core. An alternative is the joint insulated with styrenated paper and fitted with polystyrene, which, incidentally is an instance of the direct assistance of the chemist to the electrical engineer. One type of cable uses pre-impregnated paper as the insulation, employing compounds which remain solid over the cable working temperature range.

On the other hand, reference may be made to a pioneer installation of several miles of 33-kV cable where the further alternative of allowing the compound to flow has been adopted. It is claimed that with this system, known as the Continuous Flow System, compound pressure and impregnation are kept more uniform as well as the joints remaining full.

The improvement of protective coverings for cable buried in the ground is continually under attention. In this connection the incorporation of rubber tape with bitumen in the servings for corrosive conditions and for the extra protection of the reinforcement of pressure cables is an improvement which can be expected to provide a covering to meet any requirements which can reasonably be foreseen.

The Future

The evolution of post-war economy has now proceeded sufficiently to reveal in general terms the outline of the next phase of super-tension cable development. The paper presented by Mr. Haldane at this Convention has indicated three specific desirable lines of development, namely :—

(*a*) Production of cables to work at 300kV a.c

(*b*) Production of cables to work at direct voltages of the order of 500-1000kV.

(*c*) Production of submarine cable transmission lines to connect the countries of Europe.

To these may be added :—

(*d*) Investigation of alternatives to impregnated paper as an insulation.

(*e*) Investigation of alternatives to lead sheaths.

None of these problems is absolutely new. Every cablemaker has looked beyond the operating voltages at which he has attained commercial sales, and estimated his potential capability at higher voltages. In some cases private or public experiment has been made.

As far back as 1936, three of the types of cable under study by British cablemakers were tested at Arnhem, in the K.E.M.A. Laboratory. Two examples of one type of cable were constructed by British cablemakers. The test commenced with 400 load cycles with 150kV to earth applied. Subsequently some of the cables were re-sited, re-jointed (including new sealing ends) and subjected to 200kV to earth with daily load cycles. This test extended from 1938 to 1940, when it was interrupted by the invasion of Holland by the German forces. The installation was damaged beyond repair at the famous Battle of Arnhem in 1944. Samples of one of the cables were, however, obtained after the termination of hostilities for laboratory analysis. The results augur well for 264-kV working.

A British 220-kV cable is, in the near future, to be subjected to long-term field testing by connection to the French 220-kV network in the grounds of the Clamart Laboratories of Electricitè de France. A joint and sealing ends are included in the field test, and it is noteworthy that semi-conducting glaze will be used on the porcelains to control the stress from end to end. This is the first occasion on which stabilising glaze has been used at 220kV.

Submarine power transmission has been achieved at various voltages, both at home and abroad. The length of line has, in general, been short. At home, river and harbour crossings have constituted the most usual submarine project, and installation has been the main novel problem. Protection against damage by dredgers and ships' anchors has been a prominent feature of such projects and has to some extent controlled the type of installation employed.

Ever since the chemical-plastic industry commenced its rapid and phenomenal build-up, cable engineers have kept a watchful eye on the potentialities of such materials employed as insulation capable of working under high electrical stresses. This watch has been helped by the continuous research and development work proceeding in the associated cable laboratories working on insulated wire (rubber and plastics).

To date, the only discernible commercialised trends are in connection with synthetic oils, jointing materials, &c., but developments in this field may one day move rapidly, especially if the chemical resources of the country fulfil their tentative promise of rapid expansion with consequent decrease of product price.

Investigations relating to materials suitable for replacing lead as the main cable-sheathing material have been going on consistently since the late 1920s. The usage of lead as a cable-sheathing material may become uneconomical in the next decade or so, and the very considerable metallurgical effort at present applied to alternatives may introduce quite revolutionary changes in the characteristics of the all-important metal envelope.

Looked at from the point of view of these long-term studies, therefore, current and future development in the super-tension cable field might be considered merely as continuations of past activity. There are, however, other viewpoints which must be considered and which modify the position. Before examining these, let us consider in greater detail the three lines of development indicated in (*a*) to (*c*) above.

A.C. Cable for 300kV

First, the problem of designing cable to work at 300kV a.c. That this problem will be solved there is not the slightest doubt. Several types of cable have already been developed for 132kV working, which should be capable of further development to 300kV. As mentioned above, practical experiments have already demonstrated this to some degree and other experiments are in hand. The laws of behaviour of impregnated paper under 50 c/s alternating electrical stresses are sufficiently well known now to permit of confident design.

It is, of course, generally appreciated that the laws governing the distribution of the electric field between concentric cylinders are such that the cable designer's task becomes more and more difficult as the working voltage is increased. Either the maximum and mean stress values must be increased or the overall diameter of the cable will become greater than is desirable for processing, sheathing, transporting to site and laying. Considerations of capacitance and dielectric loss have to be taken into account. Research and development to reduce these characteristics in magnitude may be necessary in order to render the use of higher stresses profitable. It is believed, however, that there are no insurmountable obstacles in the design of 300-kV a.c. cables in this respect.

The query has now moved to the impulse strength aspect. Here experience and data are less well-founded. Many impulse tests have been taken on cables during the last ten years or so. Much study has been devoted to the results obtained. It has been established that cables for operating voltages from 132kV downwards, when constructed to the insulation thicknesses normally specified, are capable of withstanding the surges normally associated with the service conditions of the transmission lines in which they operate. It does appear however, that the margin or safety factor is not too high and that any attempt to reduce the radial thickness of the insulation might introduce difficulties in respect of impulse strength. In other words, the 50 c/s stress is not now the governing factor in determining cable design and dimensions.

This fact complicates matters since, until sufficient laboratory data on impulse strength have been collected and compared with experience in the field, design data for the higher voltages cannot be entirely precise.

Moreover, it has not yet been established how exactly a laboratory test can reproduce the line surge condition, or at least the worst possible surge condition likely to be encountered. Work on this problem is being actively pursued at present, not only in cablemakers' laboratories, but also in conjunction with the E.R.A. and the N.P.L. It is hoped that from this work a more suitable test for the cables than B.S. 923 will emerge. It is difficult, however, to obtain field tests in this country in the absence of 300-kV transmission lines. Some work abroad may be necessary to ensure rapid progress.

High-Voltage D.C. Cable

Turning secondly to the high-voltage d.c. cable problem, it is, at first sight, an attractive

* Abstract. Paper prepared by C.M.A. Technical Committee and presented by its Chairman, Mr. T. R Scott, British Electrical Power Convention, Torquay, June 16, 1949.

proposition to substitute direct for alternating current.

Familiarity with high-voltage d.c. testing of cables has led us to expect d.c. breakdown voltages two or three times higher than the corresponding a.c. breakdown voltage for any given cable. On this basis, working voltages (d.c.) in the range of 500kV to 1000kV appear to be obtainable. Work carried out in France and in Sweden has confirmed this preliminary viewpoint. Both solid and oil-filled cables have been checked in the laboratory and in the field.

However, it is quite a step from these comparatively elementary considerations to the design of an economic cable transmission installation working at, say, 1000kV d.c. The cablemaker will have to study the design of the cable from the viewpoint of exact knowledge of the types of converter to be employed, the characteristics of the switchgear, &c. This means that until a specific overall project can be put up for study, little real progress can be made. Development of converters, switchgear and cables must proceed in parallel, and there is obvious need for collaboration in these items. In the meantime, work on impulse strength as described above, increases the knowledge of certain relevant factors.

Long Submarine Cables

The third specific problem is that of comparatively long submarine cable lines. So far, cablemakers have managed to solve practically all problems posed to them in respect of submarine tie lines. The voltages and loads involved have not been of very high magnitude, it is true, but some of the under-water problems have been somewhat severe. One might mention the transmission of power to islands off the Norwegian coast, where the cable has had to descend rapidly to considerable depths and to ascend rapidly to the opposite shore. The main questions involved are those relating to weight, jointing, armouring and protection. The Norwegians have studied these problems with some care and have also had to consider seriously the question of compound drainage. It is unlikely that these problems will be so acute in British waters, and solutions for the latter can be guaranteed. The types of cable involved are unlikely to differ materially from those used on land lines. There is, of course, a chance that plastic cables, similar to modern communication cables for submarine working, might be developed. This will depend, however, on the working voltage required, and development of cable in this instance also is delayed by the absence of specific projects.

Work on short runs tends to encourage concentration on long lengths of cable without joints. For example, a current Norwegian project at 60kV contemplates cable lengths of 3400m of oil-filled cable. The main development here lies in handling and transportation. Lines of 25 miles or more in length require a completely new outlook.

The laying of the H.A.I.S. (Pluto) pipe-line, made on cablemaking machines, across a wide region of the Channel shortly after D-day, begets confidence in similar cable projects; albeit the problems in the cable cases are infinitely more intricate. The H.A.I.S. pipe-line represents only the outer shell of a submarine power transmission line, i.e. the sheath and armouring. The introduction of insulated conductors into this shell is the matter of greatest difficulty. It has been achieved in the case of telephone cable, so that 20 to 30 miles of cable have been shipped and laid, the whole length having one continuous lead sheath. One method of achieving abnormal length is to manufacture normal lengths of lead-covered cable and to joint these in a special way in the factory into the required length. The long length is then stripped of its lead sheath and re-sheathed in a continuous process which yields the required length. The special processes employed are, however, not easily adapted to power cables in which high-grade impregnation and searching high-voltage tests are necessary. The future development, it should be emphasised must mainly be directed to features which were not present in the H.A.I.S. project.

Organisation of Development

The main question which confronts us in all these problems is that of the mechanism or organisation of the development. The outstanding lesson of 1919-39 was the growing importance of team-work. This collaboration has been achieved substantially within the C.M.A., with the research associations and with materials suppliers, but something more is now required. Intimate team-work between the "user industry" and the C.M.A. is now a paramount necessity. This must not be taken to imply that there has not been such co-operation heretofore. Unless such had existed, much slower progress in the development of new types of cable would have been made. The situation is, however, somewhat different in considering the specific items now proposed for development.

Going back to the 33-kV developments, the costly programme undertaken was obviously a worthwhile investment by the individual cablemaker. In 1919 it could be seen that the mileage of 33-kV cables likely to be installed at home and abroad was very considerable. To a large extent the results of the development applied directly to lower-voltage cables and indirectly to the development of higher-voltage types (66kV and 132kV).

At 132kV the returns for development effort and expense were less remunerative. The mileage of cable to be manufactured was less; the cost of experimental cables and the cost of testing these (including investments in higher-voltage test-gear) were higher. It was obviously, however, still remunerative development work.

As one proceeds, however, to 300-kV a.c. and 1000-kV d.c. submarine cables for cross-channel work, &c., the industrial or commercial incentive further decreases. Certain specific installations of the type under discussion will undoubtedly be called for from time to time. Transmission planning has not yet proceeded far enough to indicate the number and value of these, but the probabilities are against very extensive use of cable therein, except perhaps in the limited submarine cable projects. Economically, since the problems must be solved both for national and also for possible export demands, the solution should be sought on the basis of minimum development effort and expense, i.e., by intensive team-work.

Technically, very much the same situation arises. These three problems have each several alternative possible solutions, but in the outcome only one or two solutions will have commercial value. No single cablemaker is likely, for example, to spend much money on development of high-voltage d.c. cables until he knows fairly precisely what types of switchgear (if any) and which type of converter (a.c./d.c., d.c./a.c.) will be used, what type of transmission is most probable, and what voltage will be called for. Some indication of the probable extent of use is also a fundamental requirement. The cablemaker can then calculate his own probable market if his solution is acceptable to the user. It is questionable whether any one cablemaker would be able to justify the development costs involved, unless on the basis of giving useful work to his development staff if perchance they should not be fully occupied.

Similarly, the development of high-voltage submarine cables is very much a matter of futility until a relatively firm transmission scheme indicating voltage, load, load factor, &c., for a specific route is forthcoming. Prospective users may, of course, reasonably retaliate by saying that the transmission planning of such projects is futile until they know what solutions the cablemakers can reasonably guarantee.

The obvious mutually satisfactory answer is national team-work. This may well involve the B.E.A. (and their advisers), the B.E.A.M.A. and the C.M.A. tackling the problems jointly and building up, eventually, complete experimental systems designed to give final answers to questions which cannot easily be solved in the laboratory.

Such development resources cannot be built up in a short space of time even if considerable financial resources are available. As has been shown in the earlier sections of this paper, experience has to be combined with skill and many "skills" have to be integrated to produce worth-while cable developments. Doubtless the same is true for all items of an h.v. transmission line.

Perhaps it will be necessary to carry such team-work beyond the bounds of national effort. The problem of connecting Great Britain with the Continent of Europe by means of a.c. or d.c. submarine cables might well call for the combined efforts of a British team, as proposed above, and other similar national teams (French, Belgian, &c.). In the initial stages such teams could at least constitute a valuable study group seeking to reject impracticable solutions and to further progress along practicable lines.

L.M.R. Telephone Equipment at Crewe

Greatly improved train and traffic control is expected to result from the recent opening of the L.M.R. new divisional control room at Crewe, which controls all train movements between Euston and Carlisle, involving 1,000,000 train miles a week. Up-to-date telephone equipment has been installed, and henceforth it will be possible for the control staff to communicate with any section of the 2400 miles of line without leaving their desks.

A photograph giving a general view of the control room is reproduced herewith. Twenty-one of the twenty-seven desks in the control room are provided with keyboards, each having capacity for thirty-six control circuits (which are common to all keyboards), and ten railway exchange lines. These exchange lines work to the Crewe automatic exchange. Each keyboard also has its own individual extension from a fifty-line P.A.X. equipment, which provides local intercommunication within the divisional operating superintendent's offices.

The keyboards are mounted at the back of the desks and are enclosed in polished wooden casings forming part of the desks. Certain of the keyboards are raised above the desk-tops to give the maximum space for train sheets, &c.

Circuit Operation

A "speak" key is provided for each circuit, whereby the controller connects his hand set to any desired line. An incoming call is signalled by the lighting of a red calling lamp above one of the "speak" keys on each keyboard. The operation of this key extinguishes the call lamp and lights green "busy" lamps on all keyboards. Outgoing calls are made by throwing the appropriate "speak" key and operating one of a group of selective ringing keys, or by dialling in the case of the railway exchange and P.A.X. lines.

On any keyboard a control circuit may be switched to any other control circuit, or to a P.A.X. extension if desired, by operating the two associated "speak" keys downwards to the position marked "connect." Such interconnection does not affect the working of the rest of the keyboard, and the controller may supervise the connection by the operation of a "monitor" key. Any further ringing on circuits which are so switched through causes the operation of a "clear" lamp and a low-toned buzzer, which can only be silenced by operating the "monitor" key. This compels the controller responsible for the connection to enter the circuit to make certain conversation has ended before breaking down the connection.

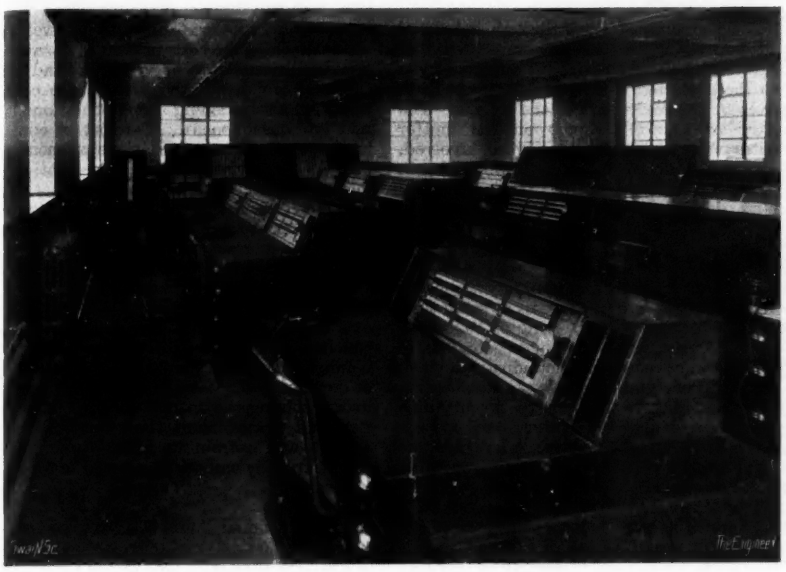
Connection between exchange lines and control circuits is prohibited and the exchange line keys have no "connect" position.

Most of the control circuits are operated on the omnibus principle, having several outstations. The divisional control room is selectively called on all such circuits. Loop or differential battery calling is used at present, but provision has been made for the conversion of certain circuits to a form of "dial selective" working in the near future.

For conference purposes certain control circuits are connected to telephones in selected private offices. The switching is performed by

relays under the control of conference keys on the head controller's desk, and during the conference the normal control room keyboards are disconnected from the circuits so switched, only the head controller being permitted to "listen-in."

All keyboards are identical and are removable from the desks for routine maintenance and repair purposes. The keyboard wiring is terminated on twelve thirty-two-point jacks which connect to a like number of thirty-two-point plugs mounted on an angle iron framework attached to the desk.



L.M.R. DIVISIONAL CONTROL ROOM, CREWE

Apparatus and Battery Rooms

An apparatus room adjoins the control room and houses the relay equipment and cable distribution frames, together with the battery chargers and lamp transformers. A test desk fitted in this room carries a spare keyboard which is used to facilitate maintenance. The spare keyboard position is connected up in the same manner as a normal working position to enable the maintenance staff to carry out tests on faulty circuits without disturbing the controllers.

The calling and busy lamps are supplied with power at 20V from three lamp transformers provided with "power-off" contactors. During power failures the calling lamp load is transferred to the main 26-V battery and the busy lamps are disconnected.

A separate battery room contains duplicate 26-V, 150A-h lead acid secondary batteries for operating all relay equipment, and a single 50-V, 20A-h lead acid secondary battery for ringing outstations.

Automatic protection of ringing key contacts and wiring is provided by means of a series relay in the main ringing battery feed, which connects a limiting resistance in circuit should the ringing battery be applied to a short-circuited line.

Power-off and other fault alarms are repeated to the head controller's desk so that the maintenance staff can be called without delay, should they be absent from the apparatus room.

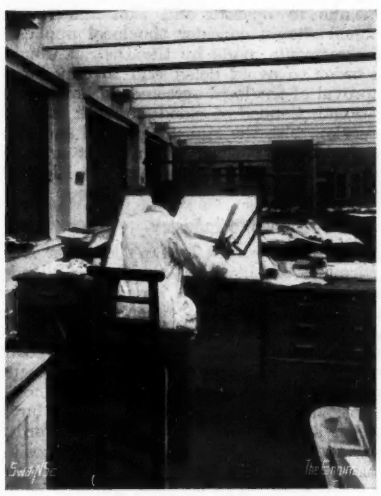
All internal cabling is done through the medium of twenty-pair polyethylene insulated P.V.C. sheathed cables. Parallel cabling to all keyboards is employed, all interconnecting being done by means of jumpers on the intermediate distribution frame. Cables between the apparatus room and the keyboards are carried in floor ducts, or alternatively in runways incorporated in the desks.

The telephone equipment was designed and manufactured at the Coventry works of the General Electric Company, Ltd., to the requirements of Mr. S. Williams, Regional Signal and Telecommunications Engineer, who was also responsible for the design of the desks and special ticket racks for the Motive-Power, Passenger-Stock and Passenger Transport Controllers.

The furniture and fittings were manufactured by the Regional Chief Mechanical Engineer's Carriage and Wagon Works at Wolverton. The assembly of the furniture and installation of the telephone equipment was carried out by the Regional Signal and Telecommunications Engineer's staff.

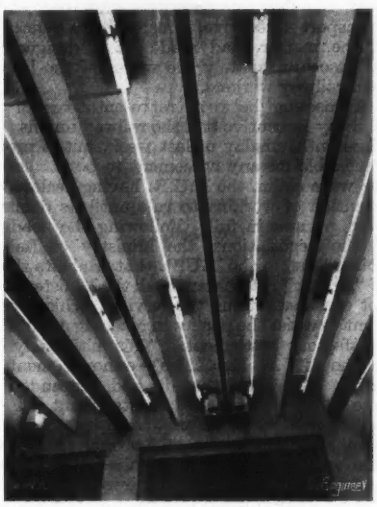
Cold-Cathode Tubes in Ceiling Louvres

In planning lighting for a drawing-office, it is important that the desired high level of illumination should be obtained without having a large number of bright fittings in the draughtsmen's field of vision, which might produce an effect of glare except when looking directly at the drawing boards. One method of providing adequate and uniform lighting from sources which are concealed at most angles of view is seen in the main engineering design office at the Wembley Research Laboratories of the General Electric Company, Ltd. This is believed to be the first installation of a louvred system using cold-cathode flourescent tubes for this purpose. The ceiling in this office already had broad transverse beams, which offered a means of cutting off a direct view of some of the cold-cathode tubes chosen for the new lighting. To provide for the considerable number of tubes required, three louvres running right across the ceiling have been fitted between each pair of beams. Each section of the ceiling between a pair of beams is thus divided into four, and there is a single line of "Daylight" cold-cathode tubes in each division. As shown in our first illustration, none of the tubes is visible to the draughtsman at normal angles of vision, so that the high illumination on the drawing boards is enjoyed with freedom from glare.



COLD-CATHODE TUBE LIGHTING

Most of the runs consist of three standard lengths of tubing mounted in such a way as to present a continuous lighting length, the ends with the electrodes being turned upwards and concealed inside boxes on the ceiling, as shown in the second illustration herewith. Transformers, with power factor correction capacitors attached, are fitted at intervals at each side of the room between the louvres, and are connected so that each transformer feeds four tubes.



LOUVRED CEILING WITH COLD-CATHODE TUBE FITTINGS

Before the present cold-cathode lighting was installed, the drawing-office was lit by three longitudinal rows of ten tungsten lamps, each using 300-W lamps in the two outer rows and 200W in the middle, a total of 8kW. The new installation takes under 5kW, and after six months' use throughout the winter gives an illumination measured on the drawing boards of 35 to 40 lumens per square foot.

Lubrication Research in the Lace Industry.—The Lace Research Association is investigating the possibilities of new lubricants for use on lace-making machines. These machines are sometimes 36ft. long and 18ft. high, and the lubrication of them has hitherto presented a problem. It is not possible to use ordinary oils as they become sticky and tend to clog the working parts, and there is no way of preventing oil from soaking into the lace fabric. The working parts of a lace machine are therefore normally lubricated by powdered graphite, which, although efficient as a lubricant, is not wholly satisfactory as lace may become soiled by it, particularly in tying up a broken thread. When that happens a thread of dark grey material runs through the white of the finished piece. It is sometimes possible to wash the stain before dyeing and dressing, but often it proves indelible. This is a point which the Association is having to keep in mind in its search for a new lubricant. It explains that any substitute must be at least as good as graphite and must either be easily removable from the lace or have no effect on dyeing. Tests of new lubricants will be made at every stage up to full-scale trials on a working lace machine before any one is recommended.

Industrial and Labour Notes

Railway Wages

After protracted discussions between officials of the National Union of Railwaymen and the Ministry of Labour's chief industrial commissioner, it was announced last Friday afternooon that the N.U.R. Executive had decided to suspend the "go slow" or working-to-rule campaign which it had agreed should begin on Sunday last at midnight. Prior to this decision, the other railway unions had directed their members to continue normal working and not to participate in the threatened "go slow" campaign ordered by the N.U.R. as a protest against the Railway Executive's rejection of its latest claim for a general wage increase of ten shillings a week and additional overtime payment for Saturday afternoon work. Both the Railway Executive and the London Transport Executive, which is also concerned in the matter, had made offers designed to increase immediately the wages of the lowest-paid railway workers.

A meeting between representatives of the Railway Executive and the railway unions took place on Thursday of last week, but it proved impossible for any agreement to be reached on the wage claim, the N.U.R. having declared its intention of working to rule until its demands were granted in full. Following the deadlock in the negotiations, the Ministry of Labour pointed out to the N.U.R. that while its threat of "go slow" action remained, the Minister could not consider lending the services of his department to assist the parties in reaching a mutually satisfactory settlement. This ultimately led to the N.U.R. Executive's announcement on Friday afternoon that it had suspended its "go slow" direction. A statement on the matter was made in Parliament the same afternoon by the Minister of Labour, Mr. Isaacs, who said that he had consulted the Railway Executive and the other railway unions, and also Sir John Forster, Chairman of the Railway Staff National Tribunal as to the constitutional procedure provided for under the agreements in the industry. It was clear, the Minister explained, that there was no provision in the agreements that compelled the parties to arbitration and both the Railway Executive and the N.U.R. considered that that machinery had been exhausted. Accordingly, he had come to the conclusion that there was no constitutional obstacle to his intervention in the present dispute.

As these notes go to press, a meeting is proceeding between the Minister of Labour and representatives of the Railway Executive and the unions concerned in the wages dispute. It was summoned on Tuesday by the Minister in order to ascertain the views on the present situation of all the parties concerned.

Changes in Wage Rates and Working Hours

Figures published in the latest issue of the *Ministry of Labour Gazette* show that the changes in wage rates reported to have become operative in the United Kingdom during May resulted in an aggregate increase of approximately £86,000 a week in the full-time wages of about 360,000 workpeople. Amongst those to whom wage increases were made were workers employed in the manufacture, maintenance or repair of agricultural machinery, hourly-rated engineering and maintenance staff employed in civil air transport, and male workers in the glass processing industry. In the first five months of this year, changes in wage rates, which were reported to the Ministry of Labour, resulted in an aggregate increase of £515,700 in the weekly wages of 3,548,500 workpeople. In the corresponding period of 1948, there were increases which totalled £864,900 in the weekly wages of 2,976,000 workpeople.

There were few changes reported in May in normal weekly working hours. People employed in the manufacture, maintenance or repair of agricultural machinery had their working week reduced from forty-five to forty-four hours. On the other hand, the normal working week of those occupied in the wallpaper industry was increased from forty-four to forty-five hours.

Trade Disputes

Stoppages of work through industrial disputes in the month of May numbered 159. Of that total, 148 began during May, and eleven which had started previously were still in progress in the early part of the month. The Ministry of Labour's report on the matter indicates that 75,700 workers were involved, directly and indirectly, in these stoppages in May and that, in the aggregate, 352,000 working days were lost. In the preceding month, 40,600 workers were affected by 139 stoppages of work and 135,000 working days were lost.

In the coal-mining industry, ninety stoppages through disputes were in progress at some time or another during May, involving 52,100 workpeople, and resulting in an aggregate loss of 270,000 working days. In the industries which the Ministry classifies as "Metal, Engineering and Shipbuilding," there were twenty-nine stoppages, involving 5100 workers and causing a loss of 26,000 working days. The transport industry accounted for thirteen stoppages of work, the number of workers affected being 13,500, with an estimated loss of 41,500 working days. This last figure reflects the effect of the recent Sunday strikes of locomotive men in the Eastern and North-Eastern Regions of British Railways.

The Ministry states that in the first five complete months of 1949 there were 677 stoppages of work through disputes, in which 203,700 workpeople participated, the aggregate number of working days lost being 729,000. In the comparable period last year, 911 stoppages involved 256,900 workers and caused a loss of 1,313,000 working days.

Wages in the Electricity Supply Industry

On Thursday of last week, the National Joint Industrial Council for the Electricity Supply Industry met to review the progress being made in the operation of the wages agreement dated May 31, 1949. A subsequent statement from the council said that it was finally decided that the District Joint Industrial Councils "were dealing in the appropriate manner with the excess rates in accordance with the terms of the agreement." It was therefore resolved that the district machinery should continue to operate and that the National Council should consider the local application of agreements made by the District Councils. In order to avoid delay and to expedite the approval of the local agreements, however, the National Council decided to seek an early interview with the Minister of Fuel and Power to elucidate questions which might arise over certain statutory provisions of the Electricity Act, 1947.

A Challenge to Industry

A statement by Sir Alexander Roger, chairman of British Insulated Callender's Cables, Ltd., which has been circulated with the company's annual report, comments on the "definite change from a seller's to a buyer's market, particularly in consumer goods." Both home and export business, Sir Alexander says, is becoming more difficult. He does not regret, however, the advent of the buyer's market and in his statement puts forward the view that it is a much more healthy position, rightly giving the best reward to enterprise and efficiency. The problem which is causing him the greatest concern in looking at the future, Sir Alexander adds, is whether those essential qualities can be given full scope under the present national and international conditions. Either, the statement continues, overseas sales must be expanded, or imports must be cut down. "It is no good," Sir Alexander comments, "blinking our eyes to the unpalatable consequence of the second course—unemployment and a lowered standard of living—with the delusion that it can't happen here!"

This, the statement claims, constitutes a challenge to industry on which the export of this country largely depend. But industry, Sir Alexander asserts, must be allowed to get on with the job. At present, he says, it is harassed by all sorts of irritations and frustrations, of which not the least is the continual threat of the widening scope of nationalisation and its consequences. The cost of coal, electricity, gas and transport, the statement points out, have all risen since nationalisation, thus increasing industrial costs of production, and now steel, which enters into the costs of a wide range of export products, may follow into the realm of unnecessary and untimely experimental nationalisation, although the present is a time when price must become the determining factor in the placing of orders by overseas buyers. As an industrialist, Sir Alexander concludes, his plea is that the Government, before it is too late, should get down to the tasks of organising the basic industries already taken over; solving the many problems of organisation and management that impede their efficiency, and refraining from causing further uncertainty by embarking on still more dubious experiments.

The National Union of Mineworkers

The annual conference of the National Union of Mineworkers is being held at Porthcawl this week, and in the course of his presidential address on Monday last, Sir William Lawther made a call for "a still greater response" from the whole of the mining community. He said that we must either produce what was needed to maintain the standards of life now enjoyed, or be faced with the necessity of accepting lesser standards. Pointing out that in the past ten years wages per shift had risen from 12s. to 34s. 1d., Sir William emphasised that all further improvements would have to be paid for by increased production.

It might be correct, Sir William continued, that the National Coal Board had made mistakes, but it had also made great improvements in a short time. It was not true that the Coal Board was embarking on a course which was injurious to the existing standards of the miners. Even before the nationalisation Bill was drafted the union had agreed that the first objective of a Coal Board must be to ensure that its revenue covered all costs and charges. That was what the Board was now trying to do.

World Economic Report

The Department of Economic Affairs of the United Nations has now completed its "World Economic Report" for 1948. It is a comprehensive document which records, among many other matters, that industrial production for the world as a whole, combining manufacturing and mining, increased during 1948 by 11 per cent compared with the preceding year, and on the average was 135 per cent of the 1937 level. Outside the U.S.A., it is stated, industrial production last year was nearly 20 per cent greater than in 1947, and was about 114 per cent of the 1937 level.

Heavy industry, the report says, continued to expand rapidly, and although it is concentrated in the more highly developed countries of the world, noteworthy advances have occurred in such countries as Argentina, Australia, Canada and Poland, and increases have also been recorded in several less-developed countries. The world production of steel ingots and castings last year reached a new peace-time record of approximately 153,000,000 metric tons, a 13 per cent rise above 1937 production.

The report claims that the world-wide shortages of fuel and power, which have hampered economic recovery since the war, were substantially overcome in 1948. The output of the major sources of energy last year was 129 per cent of that of 1937, and nearly 7 per cent greater than in 1947.

French Engineering News

(From our French Correspondent)

Now that steel production is satisfying most needs, the industry is turning towards external markets. Once modernisation programmes have been completed the industry will be able to produce 12½ million tons a year, without the Saar. Exports will be a necessity. Before the war, between 25 and 30 per cent of the total steel production was exported, whereas in 1948 exports amounted to only 5 per cent, rising to 14 per cent recently. Exports to the French Union are expected to become considerable, but the essential problem concerns exports elsewhere. French production capacity envisaged for 1952 is 12·5 million tons, or only 15 to 18 per cent more than at present. The exportable surplus of 3 to 4 million tons will be about the same proportion as pre-war.

* * *

Monsieur Pflimlin, Minister of Agriculture, opened an exhibition of agricultural machinery received under Marshall Aid recently. Referring to the Government's plans for increasing the use of machinery on French farms, he said that France now has 100,000 tractors, or three times the pre-war figure. It is hoped that by the end of 1952 France will have doubled this number, and there will be one tractor for every 200 inhabitants, and similar increases for other agricultural machinery are being planned.

* * *

Industrial development continues in Morocco, where there are now four industrial workshops, three at Casablanca and one at Fedala. Another is to be opened at Safi this year. In 1948, 2400 tons of metallurgical products were produced and twelve trawlers and fifteen fishing boats, totalling 722 tons, were built. Repairs are also carried out and when further equipment is installed activity is expected to be 50 per cent higher. Altogether, there are thirty-nine foundries, of which two produced cast steel and six aluminium and various alloys. Extensions now being carried out will lead to an increase in these figures provided raw materials are available. Fifty-one metal processing firms exist, employing 2300 workers and producing 18,000 tons of steel products annually. Ninety-two general mechanical shops employ 2500 workers engaged in maintenance and repair of rolling stock, spare-part construction, &c. Morocco has twenty brick and tile plants and five more are under construction. Six factories, employing 300 workers, are employed on the production of agricultural material and use about 1000 tons of steel products annually for this purpose.

* * *

Experience acquired in the first six months' functioning of the French atomic pile has enabled protection against rays to be perfected so that the plant can be used to maximum power. For some weeks the pile has been working at a minimum of 6kW. Outside normal working hours, which are devoted to variable power experiments, the pile has been working at 10kW. The building-up of a stock of radioactive materials has enabled a regular delivery to be made to research laboratories. Visits to the plant are organised weekly and 250 persons are able to become familiar with the scientific installations and techniques every week.

* * *

During the first quarter of 1949 output in the French nationalised mines has proved very satisfactory. Deep-mined production has increased to 1073kg per man-shift, compared with the average of 969kg during the first three months of 1948, while total manpower has dropped from 323,000 in March, 1948, to 288,900 in March, 1949. Production has risen from 4,465,800 tons per month to 4,926,500 tons.

During the first quarter of this year the total mined amounted to 13,600,000 tons, or 125,000 tons more than in the same period in 1948, and 15 per cent more than in the first three months of 1938. These results have enabled the mines to balance their budget, despite the increased production tax since January 15th.

Notes and Memoranda

Rail and Road

ROAD AND RAIL APPEAL TRIBUNAL.—The Minister of Transport has appointed Mr. N. L. C. Macaskie, K.C., to be chairman of the Appeal Tribunal constituted under Section 15 of the Road and Rail Traffic Act, 1933, on and from July 1, 1949.

MOTOR VEHICLE PRODUCTION.—The monthly statistical review prepared by the Society of Motor Manufacturers and Traders shows that in April the average weekly production of motor-cars in Great Britain was just over 7000 units, and of commercial vehicles nearly 4000 units. Among the latter group, the S.M.M.T. states, there was a marked increase in the output of battery electric vehicles, the weekly average for which rose from forty units during the first quarter of the year to seventy units in April.

INSTITUTE OF THE MOTOR INDUSTRY.—The third annual summer school organised by the Institute of the Motor Industry will be held at St. Catharine's College, Cambridge, from August 27th to September 10th. It is intended primarily for people holding executive positions, the main object being to provide opportunity for intensive study, under expert guidance, of industrial and commercial problems. The school will be divided into two weekly periods, there being accommodation for eighty students each week. Full particulars can be obtained from the Institute of the Motor Industry, 40, Queen's Gate, London, S.W.7.

BRITISH TRANSPORT'S RETURNS.—In the four-week period ended June 19th, traffic receipts of British Railways totalled £25,953,000, compared with £25,138,000 in the corresponding period of 1948. London Transport traffic receipts in the four-week period were £4,512,000, compared with £4,500,000 last year, and tolls and freight charges collected by the Inland Waterways Executive totalled £152,000, compared with £128,000 in the corresponding four weeks of 1948. Taking the first twenty-four weeks of this year, traffic receipts of British Railways, which totalled £144,757,000, were nearly £4,000,000 below those of the comparable period of 1948.

Air and Water

"TUDOR" AIRCRAFT.—Replying to a recent parliamentary question, the Minister of Supply stated that ten "Tudor" aircraft were at present being converted into freighters. Delivery, he said, would probably be completed before the end of the year.

G.C.A. AT LONDON AIRPORT.—The Ministry of Civil Aviation states that on June 30, 1949, Ground Controlled Approach (G.C.A.) at London Airport completed two years of operations. In that time a total of 5161 approaches have been completed, of which 3020 have been operational and 2141 practice. The operating staff of G.C.A. are air traffic control officers, who have received special training in this type of radar control, and a group of selected girls, one of whom acts as elevation tracker in each crew. The unit is manned twenty-four hours per day. G.C.A. equipment is also installed at Northolt, Prestwick, Liverpool (Speke) and Belfast (Nutts Corner).

Miscellanea

INSTITUTE OF INDUSTRIAL SUPERVISORS.—A London Central section of the Institute of Industrial Supervisors is being formed as a result of a meeting held on June 23rd. Mr. W. J. Izzard, of C.A.V., Ltd., has been appointed chairman of the section committee, and Mr. E. A. G. Howitt, of the Projectile and Engineering Company, Ltd., honorary secretary.

THE ENGINEERS' GUILD.—At a meeting in Cardiff, on June 24th, convened by the Engineers' Guild, a discussion on "The Guild as an Association of Professional Engineers" was opened by Mr. Bryan Donkin, M.I.E.E. It was unanimously agreed to form a Western Branch of the Guild, with headquarters in Cardiff, and Major E. I. David, M.I.Mech.E., was appointed chairman, with Mr. Hywel Jones, M.I.Mech.E., as vice-chairman and Mr. R. B. Rowson, A.M.I.E.E., honorary secretary.

TWO NEW CROSS-CHANNEL PACKETS.—We apologise to our readers and to the author for two errors which crept into the article "Two New Cross-Channel Packets," in last week's issue, page 6. The caption to the illustration "Maid of Orleans" should have read "M.V. 'Queen of the Channel' on her Trials on the Clyde," and vice versa. In describing the "Maid of Orleans" (page 7), it was stated that a covered top was provided to the inner funnel; it should, of course, have read "a coned top."

FERTILISER FACTORY FOR MYSORE.—According to *Indian Trade and Industry*, the Government of Mysore has concluded an agreement with the Chemical Construction Company, of New York, for the erection of a 50,000-ton fertiliser factory at Bhadravati. The factory, which will cost about £1,875,000, is expected to manufacture 25,000 tons of ammonium sulphate per annum. The plant is expected to go into production in another two years.

"EXIDE" CONVENTION.—Delegates to the Exide Service Agents' Convention (June 20th-24th) enjoyed a full and varied programme. The formal business of the convention included the opening address by Mr. H. V. Schofield, sales director of the Exide Company. Mr. C. G. F. Pritchett, commercial manager, told delegates something of the manufacturing side of the business, and Mr. C. P. Lockton, assistant chief engineer, gave a technical paper on batteries. The convention banquet was held on Thursday evening, when the chair was occupied by Mr. A. W. Browne, chairman of the company.

COLONIAL GEOLOGY AND MINERAL RESOURCES.—A number of exhibitions in connection with Colonial Month are being held at the Imperial Institute, one of which is devoted to the geology and mineral resources of the colonies. This exhibition has been arranged to illustrate the work of the Directorate of Colonial Geological Surveys, with particular reference to the development of mineral resources. Geological maps of a number of colonies are exhibited, together with photographs, maps and specimens illustrating the exploitation of minerals in different parts of the colonies. The exhibition will be open daily until July 20th.

ANGLO-POLISH TRADE.—The British Engineers' Association has recently published a booklet on Poland, which, it is hoped, will be of value to all United Kingdom manufacturers. It is generously furnished with statistics and deals with recent political changes in Poland. The section of primary importance to the exporter is that dealing with sales promotion, which contains practical information for those seeking to trade with the Polish nationalised industries. The booklet has been written because it was found, after the conclusion of the Anglo-Polish Trade Agreement last January, that there was no reliable post-war information on trading procedure with Poland. Copies of the publication may be obtained from the British Engineers' Association, 32, Victoria Street, London, S.W.1, at 2s. each.

BRITISH ELECTRICITY AUTHORITY SUMMER SCHOOL.—The second Summer School, organised by the British Electricity Authority, opened at Magdalen College, Oxford, on Friday, July 1st. The school was attended by 104 students representing employees of all grades in the service of the British Electricity Autnority and the Area Electricity Boards. On Friday evening, the Rt. Hon. Lord Citrine, P.C., K.B.E., Chairman of the Authority, opened the conference with a short address and at the first session of the School on Saturday morning he spoke on "A Year's Progress." The general programme for the next six days, with the exception of Sunday (when only one lecture was given) was a morning lecture followed by group discussion in preparation for a general discussion, and, in the evening, another lecture. In addition, students visited Earley Power Station and the Bodleian Library and were taken on a conducted tour of the Oxford Colleges.

THE CORROSION OF STEEL.—A joint meeting of the Iron and Steel Institute and the British Iron and Steel Research Association is to be held at 4, Grosvenor Gardens, London, S.W.1, on Tuesday, October 18th, to discuss papers on the corrosion and corrosion fatigue of steel. The meeting will begin at 10.30 a.m., and at the morning session the following papers will be presented:—"A Simple Form of Accelerated Atmospheric Corrosion Test," by Mr. R. St. J. Preston; "A Study of the Corrosion Resistance of High-Alloy Steels to an Industrial Atmosphere," by Mr. H. T. Shirley and Mr. J. E. Truman; "The Atmospheric Corrosion of Iron and Steel Wires," by Dr. J. C. Hudson; and "Climatic Effects on the Corrosion of Steel," by Mr. J. Dearden. The papers to be discussed at the afternoon session, which will start at 2 p.m., are:—"The Effect of Shot-Peening upon the Corrosion Fatigue of a High-Carbon Steel," by Mr. A. J. Gould and Dr. U. R. Evans; "Corrosion Fatigue of Steel under Asymmetric Stress in Sea Water," by Mr. A. J. Gould; "High-Speed Rotor Tests of Paints for Underwater Service," by Mr. F. Wormwell, Mr. T. J. Nurse and Mr. H. C. K. Ison; and "Electrochemical Studies of Protective Coatings on Metals," by Mr. F. Wormwell and Mr. D. M. Brasher.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

British Standards Institution

Wed., July 27th.—24, Victoria Street, Westminster, S.W.1, Annual General Meeting, 3 p.m.

Institution of Mining and Metallurgy

To-day, July 8th.—Royal Institution of Chartered Surveyors, 14, Great George Street, Westminster, S.W.1, Symposium on the Refining of Non-ferrous Metals, 10 a.m. to 5 p.m.

Institution of Sanitary Engineers

To-day, July 8th.—Caxton Hall, Westminster, S.W.1, Annual General Meeting, 5.15 p.m.

Old Centralians

Thurs., July 14th.—Chez Auguste Restaurant, 38, Old Compton Street, W.1, "The City Companies," Brigadier John French, 1 p.m.

Royal Agricultural Society

To-day, July 8th.—Royal Show at Shrewsbury.

Underground Mining Machinery Exhibition

To-day, July 8th, to Sat., July 16th.—Earls Court, London, S.W.6.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

F.D. Reference	Title	Report No. B.I.O.S.
FD 3007/48 ...	Interrogation of Dr. Demant of Peenemunde West : Notes on liquid propellants	F.R.24
FD 3046/48 ...	German Pyrotechnic Dyestuffs and Synthetic Consolidating Materials to Obviate the Pressing of Pyrotechnic Compositions	F.R.432 C.I.O.S.
FD 1016/49 ...	Electrical Induction Face Hardening of Thick Armour Plate : Results of research in the above field	XXVII–75
FD 1072/49 ...	The Anthraquinone Autoxidation Process for the Production of Hydrogen Peroxide : A description of the above process and some details of a new still and column for purification and concentration ...	XXXI–15

No. of Report B.I.O.S.:	Title	Post free s.	d.
1632	I.G. Ludwigshafen and Hochst : Notes on the Manufacture of Sulphuric Acid and of Vanadium Catalyst	2	1
1839	Welding of Plastics in Germany...	22	9
1861	Light Alloy Foundries in Germany	20	4
1869	Manufacture of Synthetic Phenol by the Chlorination Route at I.G. Farben Industries : A.G. Leverkusen...	5	8
Classified List No. 18 ...	Consolidated list under subject headings of all reports on German and Japanese Industry published up to and including March 31, 1948	1	3
Classified List No. 19 ...	Reports published between April 1 and August 31, 1948	0	3
Technical Index (Part 1) ...	Alphabetical Subject Index of Reports on German Industry : Reports published to July, 1946	5	3
Technical Index (Part 2) ...	Reports published during August, September and October, 1946 ...	1	7
Technical Index (Part 3) ...	Reports published during November and December, 1946	1	7
Technical Index (Part 4) ...	Reports published during January, February and March, 1947	2	2
Technical Index (Part 5) ...	Reports published during April/September, 1947	3	8
Technical Index (Part 6) ...	Reports published during October, 1947, and March 27, 1948 ...	2	8

Technical Information and Documents Unit, German Division, Board of Trade, 40, Cadogan Square, S.W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

Personal and Business

MR. R. J. GREGG has been appointed publicity manager of the Gas Council.

MR. E. A. AUST has been appointed traction engineer of British United Traction, Ltd.

MARINE INSTRUMENTS, Ltd., announces that its name is being changed to Kelvin and Hughes (Marine), Ltd.

V. L. FARTHING AND COMPANY states that its address has been changed to 329, Tower Building, Liverpool, 3 (telephone Central 5002 and 1768).

MR. F. W. HALLIWELL, M.I. Mech. E., has been re-elected president, and Mr. H. S. Holden, chairman, of the Gauge and Tool Makers' Association.

MR. K. S. ARNOLD, M.I. Mech. E., has been appointed a director and assistant general manager of Duncan Stewart and Company, Ltd., Glasgow.

PHILIPS ELECTRICAL, Ltd., announces that Mr. B. W. Silverwood has been appointed technical commercial welding engineer in its industrial department.

MR. E. M. DELORAINE, vice-chairman of Standard Telecommunication Laboratories, Ltd., has received the degree of Ingénieur-Docteur from the University of Paris.

MR. K. RUSSELL BRADY has retired from the position of assistant general manager of the Manchester Ship Canal Company. He entered the company's service in 1926.

MR. W. J. DRUMMOND, M.I.C.E., M.I. Mech. E., has been appointed chairman of the North-Western Divisional Board in succession to Alderman J. A. Webb, who is retiring for reasons of health.

MR. E. C. OTTAWAY, M.I. Mech. E., works manager (buses and coaches), London Transport, has been awarded the Distinction of Royal Designer for Industry by the Council of the Royal Society of Arts.

SHEEPBRIDGE ENGINEERING, Ltd., announces that is has opened a new sales office for its light engineering division at 351, Sauchiehall Street, Glasgow, C.3. Mr. L. Harrop is the local representative.

BROOKS AND WALKER, Ltd., 41, Dockhead, S.E.1. has become sole world concessionnaire for C. A. Gray, Bishops Stortford, Herts, manufacturer of vernier gauges. Mr. M. Pryce has been appointed sales manager in the firm's precision tool department.

MR. O. V. S. BULLEID, C.B.E., M.I. Mech. E., has been elected president of the Institute of Welding, and Mr C. S. Milne has been elected vice-president. Mr. Bulleid, it may be added, is shortly retiring from his post as chief mechanical engineer, Southern Region of British Railways, and has been appointed consulting mechanical engineer to Coras Iompair Eireann (Irish Transport Company).

FOLLSAIN-WYCLIFFE FOUNDRIES, Ltd., states that Mr. H. Sobey, "Sandall," Fentham Road, Hampton-in-Arden, has been appointed representative in Warwickshire, Worcestershire and South Staffordshire, in place of Mr. W. Clifford Hand who has moved to the Crown Inn, Rumwel, near Taunton, to act as representative in Devon, Cornwall, Somerset, Dorset and Wiltshire. Mr. H. Williams-Gardner, 3, Winton Square, Stoke-on-Trent, has been appointed representative in Shropshire, North Wales and North Staffordshire, and Mr. P. R. Harris, Brook House, Stowmarket, Suffolk, representative in Norfolk, Suffolk, Cambridge, Huntingdon, Northampton and North Bedfordshire. Mr. H. A. Winterbottom is to become the firm's Yorkshire representative.

Technical Reports

Shipbuilding Research Reports, Nos. 6, 7, 13, 14, 21 *and* 23. The British Shipbuilding Research Association, 5, Chesterfield Gardens, Curzon Street, W.1.—The above-mentioned reports are now available without restriction. Their titles and contents are summarised as follows :—

Report No. 6 (*R.B.*219)—*Standard Nomenclature and Symbols for Hull and Propeller Resistance and Propulsion Strength and Vibration.* Prepared by the Panel on Nomenclature of the B.S.R.A., and approved by the Institution of Naval Architects, the Institution of Engineers and Shipbuilders in Scotland, and the National Physical Laboratory.

Report No. 7 (*R.B.* 92 *Revised*)—*Code of Procedure for Measured Mile Trials.* The code is intended to detail the minimum data required and the manner of its recording for results of scientific value. In ordinary acceptance trials it may be considered expedient to forego some of the readings suggested, but it is hoped that the code will assist in establishing a standard practice in this country.

Report No. 13 (*R.B.* 114, *Second Revision*)—*Survey of Existing Information on Steam Pipes for Advanced Steam Conditions, Part I.* The report is the first of a series, and deals with the problem of ensuring that excessive stresses are not set up in the pipe-line between working and shut down conditions. The author is Mr. A. W. Jones, B.Sc., A.M.I. Mech. E., A.M.I. Mar. E., of the B.S.R.A. staff, but the report includes information on the grapho-analytical method of stress analysis and Admiralty practice, contributed by Lieut. (E.) P. T. Hoath, R.N.

Report No. 14 (*R.B.* 253 *Revised*)—*Alternating Current for Ship's Auxiliaries.* By J. E. Richards, B.Sc., Wh.Sc., (B.S.R.A. staff). The report describes the characteristics of d.c. systems and, in more detail, a.c. systems of auxiliary supply. Consideration is given to the manner in which a.c. may be applied to various auxiliaries, and the principal advantages and disadvantages are enumerated.

Report No. 23 (*R.B.*177 *Revised*)—*Bibliography on Strength of Ships.* By H. Torrance, M.Eng., (B.S.R.A. staff). A comprehensive bibliography, listed under the headings of various learned societies.

British Standards Institution

*All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.*1.

HANDBOOK OF STEEL AND STEEL PRODUCTS

B.S. Handbook No. 10. The intention of this handbook, which has a foreword by Sir John Duncanson, has been to present a comprehensive picture of the whole field of British steel products, and to give in summarised form all the standards that apply to them. Its compilation has been a co-operative effort of the whole of the British Steel Industry, acting through an editorial committee under the chairmanship of Mr. Sinclair Kerr, of the Lancashire Steel Corporation, and Mr. T. Jolly, of Guest, Keen and Baldwin's, Ltd. There are three main parts to the book, and an index. The parts are : articles describing the manufacture of steel and of steel products ; classified summaries of the essential technical requirements of British standards for steel and steel products ; other information of general interest, e.g., methods of test, heat-treatment definitions and conversion factors.

The first part starts with a section of notes on the making and using of steels, which covers a brief explanation of the essentials of steelmaking, the meaning of such technical terms as "rimming" and "killed" steels, some factors to be borne in mind in the selection of a steel, and its heat treatment and ruling section. There follow seventeen sections on various steel products. In each the manufacturing techniques are briefly described, and the applications and the dimensional and other limitations of the available products are discussed and illustrated, and as far as possible, defined. These sections deal with : steel castings ; blooms, billets, slabs and sheet bars ; forgings ; drop forgings ; plates ; sheets ; tinplate, terneplate and blackplate ; hot and cold rolled steel strip ; hot rolled bars and sections ; bright steel bars ; steel tubes ; wire and wire products ; tool steels ; rails ; steel sleepers ; railway wheels, tyres and axles ; steel supports for use in mines.

These are followed by a section of notes on wrought steels (En series). This section provides an exhaustive discussion of the range of wrought steels detailed in B.S. 970, and their respective uses. It is in this part of the handbook that most of the illustrations are placed. There are twenty-seven illustrations, for example, of various kinds of steel castings, seventeen of forgings, five illustrating section and bar rolling processes and so on.

The second part of the book summarises the great number of British Standards that have been drawn up for British steel and steel products. For convenience, these are grouped into fifteen sections, as follows : steels for general engineering—bars, billets, drop forgings and forgings, sheet and strip, castings ; steels for electrical engineering ; structural steel, including sections ; steels for ships ; pressure vessels materials ; gas cylinders ; railway materials ; tramway materials ; aircraft materials ; colliery materials ; tubes and tubular products ; wire and wire products ; rivets, bolts, nuts and fastenings. These are followed by a list of British Standards on welding or which include requirements on welding.

The final part of the book assembles much information about British Standards relevant to the subject, but usually found scattered in various publications. In twelve sections, various tensile, bend, cupping, impact, hardness and proof tests are detailed, and there are notes on chemical analysis, British and Continental test pieces, the correlation of Izod and Charpy test results and various other matters. There are also sections of heat-treatment terms and definitions, and many tables of conversion factors. The handbook is fully indexed, and is expected to be exceptionally useful to all buyers and users of British steel. **Price 25s.**

A Seven-Day Journal

The Empire Mining and Metallurgical Congress

In the course of his Presidential Address at the opening of the fourth Empire Mining and Metallurgical Congress in London, on Monday, July 11th, Sir Henry Tizard spoke at some length on the mineral resources of the world and the rate of consumption. When minerals were discovered they were extracted, concentrated, refined still further and then completely dissipated in use. That this process could not go on for ever was obvious, and we had reached a stage where the question was not of academic interest alone, but one of real practical importance. Sir Henry pointed out that some of the metals on which so much depended, such as lead and tin, could not, from existing knowledge, be certain to be available in sufficient quantities in a hundred years' time. The rate of discovery of minerals of economic importance had been steadily going down for twenty or thirty years, and we did not know if this was due to the fact that minerals were not there, or to the fact that the methods of finding them were out of date. Optimists could take encouragement from the fact that, great though the consumption of minerals was, the actual volume which had been consumed was very small when compared with the size of the earth. On the subject of coal, Sir Henry estimated that the total volume extracted had been between 10 and 20 cubic miles, and to this could be added one cubic mile of petroleum and about a cubic mile of metalliferous minerals. When this volume was compared with the earth's friable land surface of about 60 million cubic miles, it would be odd that, if in this large volume, there were not many more cubic miles of useful and exploitable material. On the subject of discovering minerals, the speaker considered that the mining geologist must now become more and more an applied physicist, and such an applied science needed to be continuously developed on a firm foundation of fundamental knowledge. The basic science of geophysics needed to be encouraged and stimulated in its broader aspects, and possibly some of the great mining corporations would consider how they could provide this stimulation. The first day of the congress concluded with a banquet at Guildhall, which was attended by the delegates from sixteen countries of the British Commonwealth and twelve other countries. Scientific sessions of the conference began in Oxford on July 12th.

The National Coal Board and Cleaner Coal

The National Coal Board has announced this week that the largest coal cleaning plant in the country is to be installed at Lynemouth Colliery, Northumberland. Not only is the new plant an integral part of the programme which the Board is putting in hand to improve the quality of coal, but it is also a section of a reconstruction scheme for Lynemouth and Newbiggin collieries in the Northern Division, which is expected to cost £2,500,000. It is anticipated that when the scheme is complete the output of coal from these collieries will be increased from 600,000 tons to 1,500,000 tons a year. Work on the Lynemouth cleaning plant, which will cost £731,000, will, it is hoped, be carried through in the next two years, and all the coal from the colliery, as well as from Ellington, one and a half miles away, will be cleaned there. The new plant, it is claimed, will be capable of dealing with the largest pieces down to the finest particles, and will clean 800 tons an hour. The Board says that three cleaning processes are to be employed. Coal between 8in and 1½in in size will be dealt with by a Ridley-Scholes washer, in which coal is passed through a bath containing a mixture of finely ground magnetite in water. The dirt sinks, and the clean coal which floats is carried away by a stream of liquid, drained, and then sprayed to wash off any adhering magnetite. Smaller coal, of from 1½in to $^{1}/_{50}$in in size is to be treated in another plant designed by the Automatic Coal Cleaning Company, Ltd., whilst the finest particles below $^{1}/_{50}$in will be dealt with by a froth flotation plant designed by Unifloc Reagents, Ltd. The Mitchell Engineering Group is the main contractor for the complete installation embodying the three cleaning systems.

Return of the Atlantic Liner "Ile de France"

On Tuesday, July 12th, we were invited by the French Line to inspect at Le Havre the 25,330 gross ton Atlantic liner "Ile de France," which, on Thursday next, July 21st—nearly twenty-two years after her maiden voyage—will resume her six-day crossings from Le Havre to New York, calling at Southampton and Plymouth on the outward and inward voyages respectively. This famous liner has now been reconverted internally at a cost, it is stated, of between six to seven times the original price of the ship in 1926. A feature of the ship's reconstruction is the smaller passenger complement, which has been reduced from 1546 to 1345 first-class, cabin-class and tourist-class passengers. That reduction has enabled better cabins and public rooms for all classes to be provided. Some new features include the gay Café de Paris and the first-class salon, which contains some gold lacquer panels salved from the "Normandie." The theatre, which is designed to seat 350 persons at cinema performances and plays, and the swimming pool are available for the use of both the first-class and the cabin-class passengers. The cabin-class salon and smoking room are connected by internal stairway, which has glass treads illuminated from the inside. Air conditioning is used freely and the space so treated is believed to be the largest on any liner so far built. The main and auxiliary propelling machinery has been completely overhauled and modernised, and we understand that a speed of about 23 knots was attained on the recent trials. The work of reconstruction was carried out at the Penhoet shipyard at St. Nazaire.

The Late Mr. John Aiton Kay

It is with deep regret that we have to record the death, on Friday, July 8th, following an operation, of Mr. John Aiton Kay, the editor of our esteemed contemporary, *The Railway Gazette*. Mr. Kay, who was 67 years of age, received his education at Mill Hill School, and quite early in life showed an aptitude for technical journalism. In 1896 he joined the editorial staff of George Newnes, Ltd., and was given charge of the model engineering section of the boys' paper, *The Captain*. In 1902 he was appointed assistant editor of the weekly paper, *Transport*, and in 1904 that paper was reorganised under American auspices under the title of *The Transport and Railroad Gazette*. At that time the journal was owned by the *Railway Age* of America. Mr. Kay quickly realised, however, the advantages which would accrue to the railways of Great Britain, if the journal was British-owned. He went to the United States in 1910, and acquired for British interests the journal published in Britain, which in 1905, had been changed in name to *The Railway Gazette*. On his return, the company, Transport (1910), Ltd., was formed, and Mr. Kay was appointed its managing director and secretary. He became chairman and managing director in 1931, and continued to hold these positions until September, 1945, when the control of the company passed to Odhams Press, Ltd., and he became deputy-chairman and managing director. Under Mr. Kay's editorship, the *Railway Gazette* prospered, and *The Railway Magazine* was added to the many journals and directories now published by the Tothill Street Group, among which we may mention *The Crown Colonist*, with the founding of which Mr. Kay was closely associated. Throughout his long and successful career Mr. Kay maintained a keen interest in all railway matters, both at home and abroad. With his increased responsibilities he retained the editorship of *The Railway Gazette*. His genial personality and friendship won for him a very large circle of acquaintances and friends among officers on the railways, and principals in the railway industries. Just before his illness and operation he had returned from a visit to the Rhaetian Railway in Switzerland. His death is a severe loss to his firm and to the many friends who knew him.

Takoradi Harbour Extensions

It is announced that Taylor Woodrow Construction, Ltd., of Southall and London, is the successful contractor for the extension and development of Takoradi Harbour, on the Gold Coast, at a cost of £2,250,000. The work is to be carried out for the Government of the Gold Coast. The consulting engineers for the extension and development of this harbour are Messrs. Rendel, Palmer and Tritton of Westminster. The harbour is expected to play an important part in development of trade with the West African colonies. The scheme consists of new timber wharves, and an extension to the existing main quay. New sheds and warehouses are to be constructed, together with new railway facilities, including a running shed and a marshalling yard. The existing oil berth and the bauxite loading conveyors are to be moved to new positions, and about £230,000 is to be spent on new electric cargo handling cranes. Cox's Fort Hill is to be removed, which will mean an excavation of about 1,600,000 cubic yards, which material will be used in reclamation. A total of 100,000 cubic yards of concrete will be used in the construction of the quay walls, and 1700 tons of steel work will be required for the buildings. About twelve miles of railway track will be laid down. We understand that the cement, steel, and contractor's plant needed will be supplied from Great Britain. It is expected that the first section of the new harbour will come into use next year, and that the whole works will be completed in 1952. Taylor Woodrow Construction, Ltd., is already engaged in contract work in the Gold Coast, and has contracts in other parts of West Africa and in East and South Africa.

Underground Mining Machinery Manufacturers' Luncheon

Speaking at a luncheon which followed the opening of the exhibition organised by the Underground Machinery Manufacturers at Earls Court, the President, Mr. James Anderson, said that although they had been unable to meet all the demands of the home industry during the immediate post-war years, mining machinery manufacturers had been able to release more and more equipment for export. Great efforts were being made to seek fresh and regain old markets. A later speaker, Sir Eric Young, the production director of the National Coal Board, emphasised the importance of machinery for increasing the output of the coal mines. In this country, he said, mechanisation in mines was still in its infancy and much work remained to be done in the development of plant specially suited to the particular problems of British mines. Output must be increased and costs cut and unless costs were quickly reduced to a level which inland prices could sustain, industry would face a serious crisis in the near future. The most urgent task was to increase the output per coal face worker in the mines to four tons per shift—nothing less would satisfy requirements. To this end mechanisation in the mines could play a big part if existing plant were used fully and new plant developed specially to suit the working conditions.

The Underground Mining Machinery Exhibition

No. II—*(Continued from page 35, July 8th)*

WE continue the description of some of the interesting plant which is being shown at the exhibition of underground mining machinery at Earls Court. This exhibition closes to-morrow, Saturday, July 16th.

Distington Engineering Company, Ltd.

A selection of the equipment made by the Distington Engineering Company, Ltd., of Chapel Bank, Workington, under licence from the Goodman Manufacturing Company, of the United States, includes shortwall coal cutters, conveyors and loaders.

The company's 512 shortwall coal cutter, illustrated in Fig. 15, is driven by a 45 h.p. motor and can be arranged for either manual or hydraulic control. The feed mechanism, which is controlled through two sets of planetary gears, is housed in an oiltight steel casing separated from the driving motor compartment. One set of planetary gears operates the right-hand rope drum and the other the left-hand drum. Each planetary assembly has two brake bands, which operate on friction wheels. These brake bands work in pairs and can be actuated to engage either a low cutting speed or a high flitting speed.

Each rope drum, which can be disengaged from the driving mechanism by a pin clutch, is provided with a brake to prevent the rope from unwinding when not in use. Rope movements are simplified by the double swivel sheaves at the control end of the machine, and tilting shoes are fitted to permit the cutter to be elevated at either or both rear corners.

The standard cutting feed of the machine is 28in per minute, and the nominal cutting feeds range from 16in to 32in per minute, alteration of the cutting feed being effected by changing the worm shaft and worm gear.

A vertical shaft driven from an intermediate shaft through bevel gears carries the cutter chain sprocket and the sweep of a "Bugduster" or gummer. The cutter chain sprocket at the normal rotational speed of the vertical shaft gives a chain speed of 556ft per minute.

The "Bugduster" sweep on the cutter chain sprocket shaft feeds the cuttings brought out on the chain into a screw type conveyor driven by roller chain from the intermediate shaft of the cutter. This device, it is claimed, places more than 90 per cent of the cuttings in a neat pile some 6ft away from the coal face.

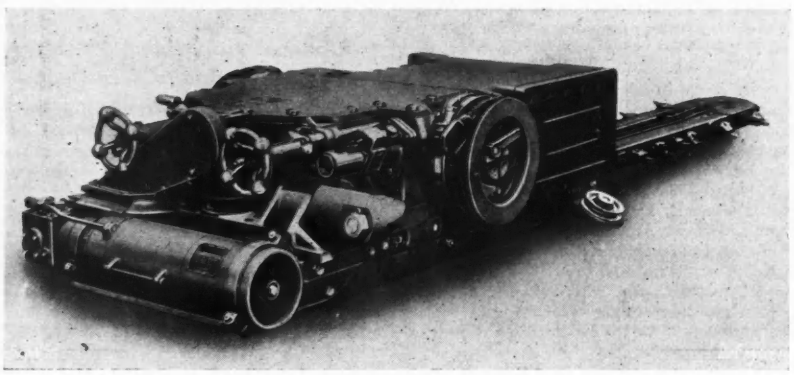


FIG. 15—SHORTWALL COAL CUTTER—DISTINGTON

A shaker conveyor fitted with a duckbill loader is shown in operation on the firm's stand. This shaker conveyor can be used independently, but is commonly employed in conjunction with a loader. An installation of this type is stated to be mainly applicable to run and pillar mining, where loading can be carried out at the same time as cutting and drilling operations are in progress.

The shaker trough conveyor line is actuated by the energy stored in a motor-driven fly-wheel in a compact drive unit. During the first half of the operating stroke imparted to the conveyor trough the fly-wheel stores energy, which is then used in the second effective half of the stroke. Three sizes of driving unit are made and each has two lengths of operating stroke, which can be quickly changed. The driving unit is coupled to the drive trough by two heavy pillar rods, as can be seen in Fig. 16.

The power for operating the duckbill automatic loader at the end of the conveyor line is taken from the shaker drive through the trough line. Between the duckbill shovel trough and the line are interposed an operating carrier, a feeder trough and a swivel trough. A telescopic trough can be used to extend or retract the shovel 10ft or 13ft in addition to the 12ft of the above loading mechanism. The shovel is built with a stiffening prong, which provides a small sharp point of contact with the coal.

The operating carrier by which the extension and retraction of the shovel trough are controlled is arranged at the head of the feeder trough which transmits the motion of the conveyor line, and the shovel trough is threaded between grip blocks on the carrier. These grip blocks are actuated by levers duplicated on each side of the carrier. By movement of either of the levers the grip blocks can be operated to release or clamp the shovel trough to the feeder trough to advance or retract it. Spring-loaded safety gear on the operating carrier releases the grips if the shovel strikes an obstruction. The swivel trough interposed between the feeder trough and the main trough line permits the duckbill loader unit to be swung to an angle of 30 deg. to either side of the centre line.

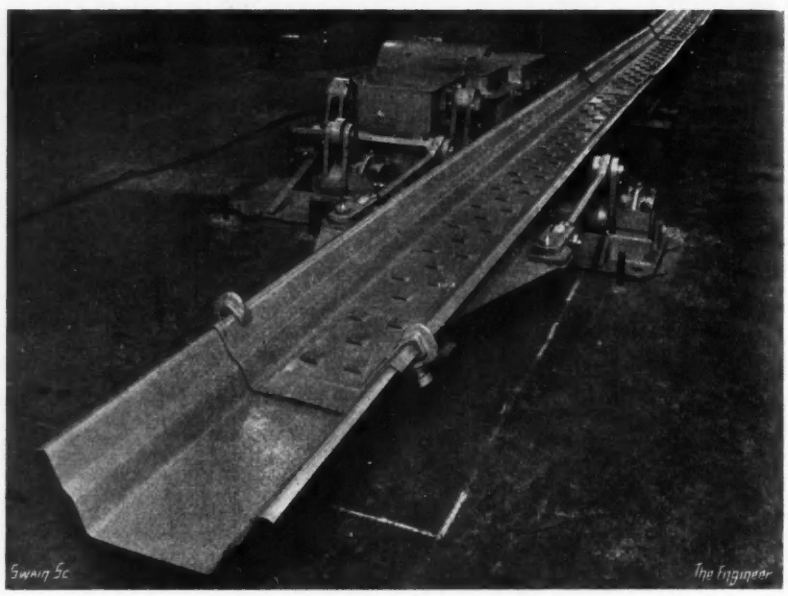


FIG. 16—SHAKER CONVEYOR AND DRIVE—DISTINGTON

This company is also showing a complete 30in troughed belt conveyor system and a loop take-up for 60ft of belting, together with a range of accessories for conveyors.

Ruston and Hornsby, Ltd.

Oil-engined locomotives have been made for underground haulage for some seventeen years by Ruston and Hornsby, Ltd., of Lincoln. The company is now making these locomotives in six sizes from 20 h.p. to 100 h.p., and visitors to the exhibition can see a typical selection of the engines built for service in gassy and gas-free mines.

The design and equipment of the types of locomotives built for gauges from 1ft 6in to 3ft 6in follow closely the same lines. The smallest engine made can be seen in the photograph reproduced in Fig. 17. A rigid fabricated steel frame is carried on four solid steel wheels, which are pressed on to axles rotating in bronze bearings in dustproof axleboxes. Motive power is supplied by one of the firm's standard four-stroke compression ignition engines. These engines have heavy-duty cast iron monobloc housings fitted with renewable wet liners. An oil

bath air filter is fitted to each engine and the exhaust manifold is water-cooled.

A flexible disc coupling is fitted between the engines and the gearboxes and drive is transmitted from the gearbox equally to both axles through short roller chains which have radius rod adjustment. This drive arrangement is designed to obviate the possibility of snatch and is claimed to be particularly advantageous when the locomotive is running on uneven tracks and where short-radius curves have to be negotiated.

The gearboxes are of the constant-mesh type, giving three speeds in each direction, gear changing being effected by the movement of a single hand lever. Each gear has its individual clutch, and when the lever is moved one clutch is automatically disengaged and another engaged. Reversing is effected by the operation of a separate lever. When engaging a gear there is no inertia to overcome, as the gear and clutch unit is coupled directly to the engine and is constantly revolving.

On the engines which are not flameproofed an exhaust conditioner box is fitted to remove the irritant constituents of the exhaust gases. On the flameproofed locomotives flame traps are fitted to the air inlet and to the exhaust outlet from the filter box.

In Fig. 18 we illustrate one of the 100 h.p. mine locomotives made by Ruston and Hornsby, Ltd. This locomotive is made for gauges of 2ft 6in, 3ft and 3ft 6in., and has an overall length of 18ft 7in, with a width of 5ft and weight in working order of 15 tons. It has three speeds in either direction, the first gear giving up to 4 m.p.h., the second 7½ m.p.h. and the third 12½ m.p.h. Based upon a starting resistance of 20 lb per ton in first and a rolling resistance of 15 lb per ton in second and third gears, the tractive effort of the locomotive at the above speeds is 7850 lb, 4200 lb and 2500 lb respectively.

The locomotive has a Ruston "6 VRHL" six-cylinder, four-stroke engine with a maximum rating of 100 b.h.p. at 1500 r.p.m. Power is transmitted through a Vulcan-Sinclair scoop-controlled fluid coupling, designed to provide a cushioned drive and smooth take-off. Drive from the coupling is transmitted to a jackshaft through a three-speed "S.S.S. Powerflow" gearbox. In this box gear engagement is effected by synchro self-shifting clutches, changes of speed being made by the operation of a single lever. The jackshaft driven by the gearbox has a crank arm at each end, which transmits the drive to the wheels through blade and fork coupling rods.

The exhaust conditioner is housed behind removable panels at the front of the locomotive and access to the conditioner box is obtained by swinging back the hinged buffer. When the engine is running the cooled gases from the water-cooled exhaust manifold are introduced into a water chamber in the conditioner box. After passing through the water the gases are led to a spiral chamber, which imparts to them a centrifugal motion which cleans them and removes much of the suspended water vapour. After passing through flame traps the gases are exhausted to the atmosphere. One flame trap is fitted to the air inlet of the engine and two on the exhaust outlet from the conditioner box.

The Westinghouse air brake equipment fitted to the locomotive acts on all wheels, and train pipe connections can be fitted when the engine is used for hauling braked trains. The driving cab is arranged to give the maximum possible visibility down both sides of the locomotive and removable steel panels give clear access to all parts for maintenance and overhaul purposes. The photograph we reproduce shows the locomotive with the inspection panels removed.

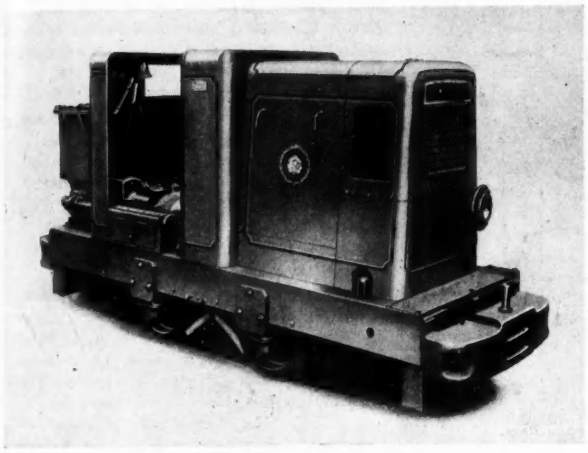


FIG. 17—3½-TON MINE LOCOMOTIVE—RUSTON

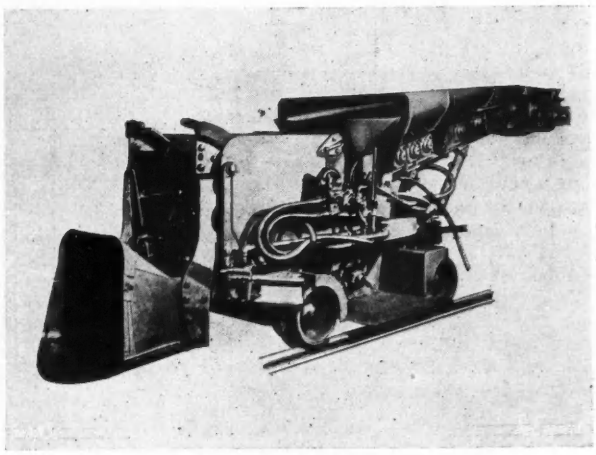


FIG. 19—½-CUBIC YARD "ROCKERSHOVEL"—EIMCO

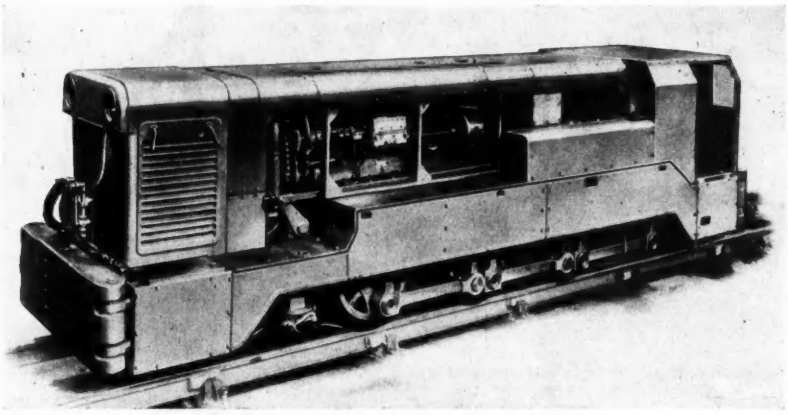


FIG. 18—100-B.H.P. MINE LOCOMOTIVE—RUSTON

EIMCO (GREAT BRITAIN), LTD.

The mining and tunnelling equipment on the stand taken by Eimco (Great Britain), Ltd., of Upper Wortley Road, Leeds, 12, includes representative examples of the range of "Rockershovel" loading machines which are now being made in this country. These machines are made in various sizes for handling up to 14 tons of material a minute under a wide range of conditions. They are built for either compressed air or electric motor drive and can be arranged for mounting on trackless tracks or running on rails.

The compressed air operated rail-mounted "Model 40" machine, shown in Fig. 19, is fitted with a ½ cubic yard capacity bucket and is designed to load material at an average rate of 4 tons per minute. It consists essentially of a heavy frame having a swinging bucket at the front and a hopper-fed belt conveyor at the rear. All movements are controlled from an operator's platform at the side of the machine.

In operation the machine, with the bucket lowered, is driven under its own power by an 18 h.p. air motor into the pile of material. The bucket is pivoted high up in the main frame and through a roller chain driven by an 18 h.p. air motor is swung upwards and over the body of the machine to dump its contents into the hopper at the rear. An endless belt conveyor, carried along a jib extending rearwards from the machine, removes material dropped into the hopper. Trucks coupled to a drawbar at the rear of the machine receive the material as it drops from the conveyor. The body of the machine can be swung in an arc on the main frame by a 6 h.p. motor to allow the bucket to cover a face of 12ft to 15ft on the material to be removed.

On the smaller sizes of "Rockershovel" the belt conveyor is not fitted and the bucket

discharges over the body of the machine directly into trucks.

AUSTIN HOPKINSON AND CO., LTD.

Hoists of various sizes for a wide range of duties and for compressed air or electric drive are to be seen upon the stand taken by Austin Hopkinson and Co., Ltd., Delta Works, Audenshaw, Lancs.

One of the larger units for scraper haulage work is illustrated in Fig. 20. This machine has two 12in diameter drums and takes 580ft of §in diameter rope. It is driven by an electric motor of 35 h.p. at 1000 r.p.m. and hauls at a speed of 200ft per minute, the average rope pull being 5000 lb.

In this machine the drum shaft is mounted in ball and roller bearings in a heavy centre piece, which, with two side members, forms the rigid main frame of the unit. The two sides and the centre piece are connected

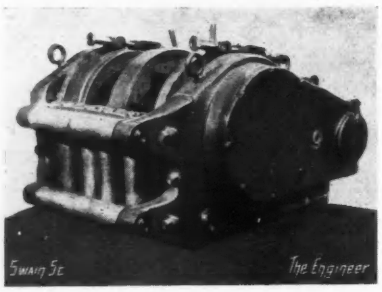


FIG. 20—SCRAPER HAULAGE GEAR—AUSTIN HOPKINSON

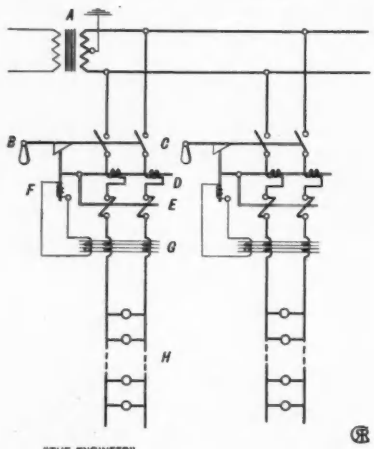
through two heavy beams of circular section which pass through the bottom corners of the centre piece. The ends of these beams are reduced to form spigots on which the gearbox on one side and the cover end on the other are located and fixed. When these three members are pulled up on the beams they form a rigid assembly, designed to withstand any tendency a heavily loaded drum shaft may have to whip. Rearwards projections of the side members are rigidly connected through the driving motor housing and a heavy cast yoke at the front carries the rope guide-rollers.

Drive from the motor is transmitted through double reduction gears to the main shaft, on which the two rope drums are mounted on ball and roller bearings on each side of the centre piece. Each of the rope drums is driven through internal gear rings at its outer end. The drive is transmitted from the main shaft through sun and planet gears, which come into effect when band brakes are applied by movement of operating levers conveniently arranged at the rear of the machine. All shafts in the unit are mounted on ball and roller bearings and the gearing is oil bath lubricated.

SIEMENS-SCHUCKERT (GREAT BRITAIN), LTD.

An earth leakage device for individual lighting sub-circuit protection is to be seen amongst the flameproof underground electrical equipment on the stand of Siemens-Schuckert (Great Britain), Ltd., Great West Road, Brentford, Middlesex.

In connection with this device the makers point out that the provision of earth leakage protection for underground lighting circuits has not hitherto been usual, particularly on single-phase circuits. Where it has been applied, the protective apparatus has usually been fitted in the transformer panel controlling the lighting system, which in most cases consists of several sub-circuits, each feeding a group of lamps. As a result an earth fault in any one group of lamps not only cuts off that group, but also all the other sub-circuits connected to the transformer panel. As the various groups of lamps may be situated some distance from one another, it is clearly undesirable that a fault on one



A Lighting transformer
B External handle of circuit breaker
C Main contacts of circuit breaker
D Short circuit trip
E Overload trip
F Earth leakage trip
G Earth leakage device
H Group of lamps

FIG. 21—EARTH LEAKAGE DEVICE DIAGRAM—SIEMENS-SCHUCKERT

group should affect the complete lighting system.

The earth leakage device developed by the company can be applied to individual sub-circuits, so that only the faulty group of lamps will be disconnected on the occurrence of the earth fault, the other sub-circuits connected to the same transformer panel remaining unaffected and still operative.

The device comprises a core balance transformer for single-phase circuits, linked to a double-pole circuit breaker which controls

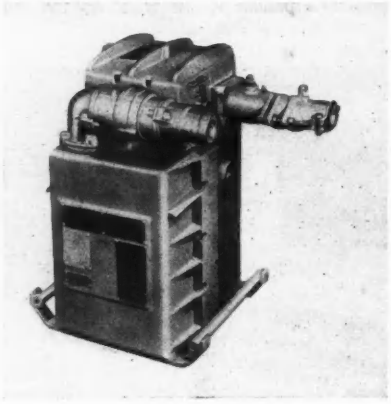


FIG. 22—BOLTLESS DRILL TRANSFORMER PANEL—SIEMENS-SCHUCKERT

each sub-circuit. The core balance transformer carries the main sub-circuit current, rated at a maximum of 10A and is designed to trip the circuit breaker should an earth fault cause a leakage of 0·6A.

The apparatus is mounted together with the circuit breaker in a flameproof box which also contains bus-bars. Boxes are bolted together to form a distribution board for the complete lighting system, fed from one lighting transformer panel. Thus a 2-kVA or 3-kVA transformer lighting panel could feed, say, a five-way distribution board comprising an incoming cable gland and five circuit breakers, each with its individual earth leakage device, controlling five groups of lamps. These groups, so far as earth leakage protection is concerned, would be independent of one another. Moreover, each circuit breaker also incorporates overload and short-circuit gear designed to trip on the occurrence of those faults in addition to the earth leakage fault. To reclose the circuit breaker after the fault has cleared, the external handle on each circuit breaker box is closed; as no fuses are used, there is no necessity to open the box to effect replacements.

The diagram reproduced in Fig. 21 shows the connections of the circuit breakers, incorporating overload, short circuit and individual earth leakage protection to the low-tension side of a lighting transformer.

A number of electric drills for coal and stone cutting are shown on attachments for various classes of work, and in this connection the drill transformer panel, illustrated in Fig. 22, is of some interest. No cover bolts are used on this panel, the covers at front and top being secured by a simple wedge device actuated through a shrouded screw by means of a box spanner. The top part of the panel forms two separate flameproof chambers. One contains three main terminals and can take sealing boxes and glands on one or both sides so that the main cable can be taken through the panel. The other chamber houses a reversing isolator. The interlock between the isolator and the main front cover is such that the isolator cannot be operated until the flange gap is less than the permissible amount at all points of the flanges. The main chamber contains the transformer, a circuit breaker with thermal overload, short-circuit and earth-leakage releases, and a contactor with intrinsically safe pilot circuit for remote control.

GULLICK, LTD.

The hydraulic "Coalburster" made by Gullick, Ltd., 3, King Street, Wigan, has for a number of years been used in collieries where gaseous conditions prevail. It is used for dislodging coal which has been either undercut, overcut or sheared, and is applied in the same way as explosives through a hole bored in the coal at a suitable distance from the cutting vent. The "Coalburster" consists briefly of a stainless steel bar, 2¾in in

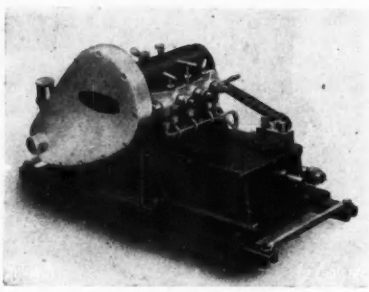


FIG. 23—"COALBURSTER" PUMP—GULLICK

diameter, chambered at intervals along its length to accommodate telescopic pistons. A hole bored along the length of the bar connects the bottom of the chambers to a hydraulic pressure supply line. When water is pumped into the chambers at the back of the pistons they are forced outwards to burst down the coal in the wall.

Hydraulic power to feed a line of bursters can be supplied by the remote-controlled pump, illustrated in Fig. 23. This pump is of the

three-plunger type, driven by a 5 h.p. electric motor through a roller chain. The pump is fixed at any convenient point in a mine roadway and provides a constant supply of water at high pressure to a flexible pipe-line slung on the props along the working face. Stop taps are inserted at intervals along the pipe to enable one or more bursters to be used as and when required. When bursters have been inserted in holes in the coal face it is only necessary to connect a flexible tube to the face service line and turn on the tap. When the burst has been made the tap is closed and the pressure in the service line

FIG. 24—CUTTER HEAD—GULLICK

rises to a predetermined value, then a remote control valve comes into effect to stop the motor of the pump. When a tap is opened the reduction of pressure in the line restarts the pump motor.

In Fig. 24 can be seen one of this company's latest cutter heads with the bits arranged for boring holes up to 3½in diameter and using standard 1 11/16in diameter "split-shank" bits. By having the alloy-tipped bits split into two parts either tip can be changed in case of damage without interfering with the other. A core cutter in the centre of this type of bit is designed to cut out the core in large pieces when boring instead of grinding it to powder.

ANDERSON BOYES AND CO., LTD.

Prominent amongst the coal-cutting plant exhibited by Anderson Boyes and Co., Ltd., of Motherwell, is the "A.B. Meco-Moore" combined coal cutter and loader. This machine is now fairly widely known amongst mining engineers. But, as it combines the functions of cutter and loader and incorporates so many interesting features, no article dealing with the exhibition would be complete without some details of this noteworthy British machine. The design and operation of the cutter loader has been described in detail in papers presented before the Institution of Mining Engineers by (Sir) Thomas E. B. Young, Mr. W. H. Sansom and Mr. Forrest S. Anderson.

The cutter loader was originally designed by the late Matthew Moore, of the Mining Engineering Company, Ltd., of Worcester, and the design and construction of the present machine is the outcome of close co-operation between the Mining Engineering Company, Ltd., and Anderson Boyes and Co., Ltd.

The machine is used primarily for longwall

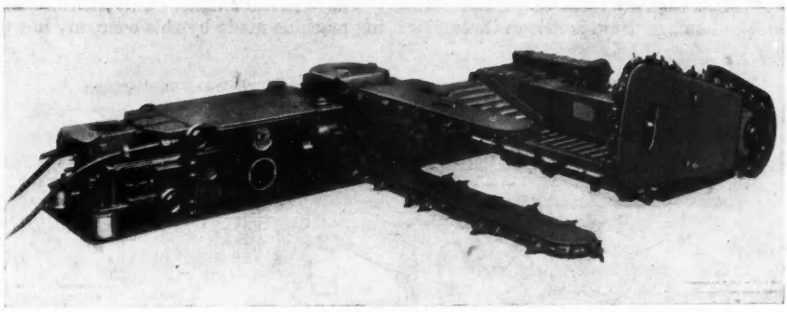


FIG. 25—"A.B. MECO-MOORE" CUTTER LOADER—ANDERSON BOYES

mining and basically consists of a cutter unit coupled to a loader unit which has a shear jib mounted at the end of its structure. The following is a brief specification of the "low type" machine, which operates on coal seams down to 3ft thick :—

Weight	10 tons
Overall length	16ft 9in
Overall width	3ft 1in
Overall height with top jib ...	2ft 7in
Overall height without top jib...	2ft
Power unit...	Two 60 h.p. a.c. motors
Minimum height of upper jib ...	2ft 1in floor to bottom pick
Width of web	5ft 6in, 5ft or 4ft 6in
Height of shear jib	2ft 6in up to 6ft 6in in suitable stages
Shear jib height adjustment ...	4in to 5in according to size of jib

In operation, as the machine moves along the coal face it makes two horizontal cuts in advance of a vertical cut, which is made by the shearing jib. When the section of coal cut by the machine breaks up and falls it is lifted over on to the conveyor by the rotary loading bar which is mounted along the leading edge of the conveyor.

The general lay-out of the cutter loader can be seen in the photograph reproduced in Fig. 25. The cutter unit consists of a double motor driving unit, with a gearcase at one end housing the haulage gear mechanism and a gearhead at the other end on which is mounted horizontal undercutting and overcutting jibs. Detachably attached to the cutter unit and projecting at right angles to it is the loader unit consisting of driving gearboxes, and a transverse slat conveyor combined with a rotary loading bar carried on a rigid structure, having a triangular shaped shearing jib bolted on a rigid angular plate at its outer end.

Two 60 h.p. a.c. motors used to drive the machine are arranged side by side in the motor frame, one to drive the horizontal cutting chains and the other the loader unit, both through gearing incorporated in the gearhead of the cutter. The drive for the loader unit is taken across from the gearhead by a detachable shaft, and the drive for the shearing jib is also taken from a detachable shaft from the gearbox in the loader unit.

The cutter chain drive is so arranged that either or both of the cutting chains may be engaged or disengaged as conditions dictate. By the use of different heights of jib bracket the height of cut of the upper jib may be varied, the minimum height being 2ft 1in from the floor to the bottom of the picks. A modified design of gearhead can be fitted which allows the height of the upper jib to be adjusted hydraulically within a limited range for use in special conditions.

The conveyor consists of an endless rubber belt fitted with steel slats and driven though chains from sprockets on the driving shaft. A rotating loading bar which extends along the length of the conveyor frame is fitted with a series of picks arranged in double helical formation. As the bar rotates the picks pass through a comb in the leading edge of the conveyor frame and lift the bottom coal and transfer it on to the conveyor belt. The picks at the same time help to break up the bottom coal into suitable sizes for loading. It should be pointed out that the loader bar is of larger diameter than the width of the kerf cut by the lower horizontal cutter chain, and its action also serves to accelerate the fall of the coal from the cut-away sections of the face.

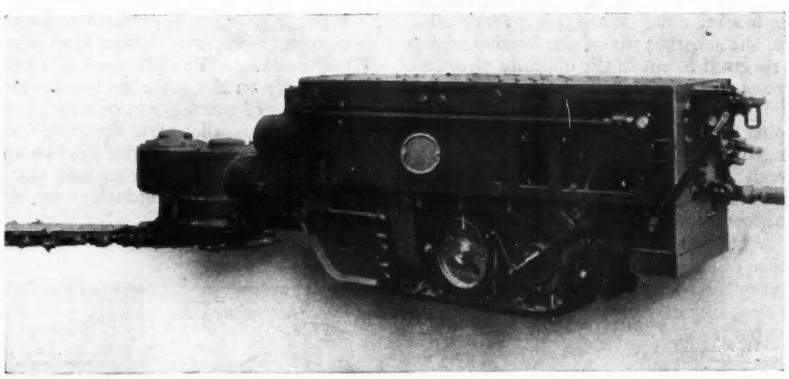


FIG. 26—UNIVERSAL ARC SHEARING MACHINE—ANDERSON BOYES

In order to remove fines which would tend to pack up the conveyor belt, a long worm fitted on the underside of the discharge end at right angles to the belt discharges the fines to one side, to be dealt with by one of the gummers. The gummer is of the single-

worm type, situated adjacent to the bottom cutting chain to remove the gummings produced and discharge them directly on to the main face conveyor.

Double-rope haulage is employed on the machine and a large-diameter haulage drum is designed to take 45 yards of §in diameter rope. The haulage drum is driven through a multi-plate friction clutch, which serves both as a control and a safety device. The maximum haulage speed normally provided for the machine for cutting purposes is 27in to 30in per minute, which can be varied in steps by means of an adjustable ratchet feed to give a minimum speed of 4½in per minute. A fast flitting speed of 40ft per minute is also provided.

The machine is designed for working in both directions, and when it has reached the end of a run the cutting unit can be disconnected and transferred to the opposite side of the loading unit. When this reversal takes place, the shearing jib on the loading unit is also reversed to cut in the opposite direction. To make this possible the jib is mounted on a swivel joint on its supporting angle plate. By undoing the holding bolts the jib can first be swung into a horizontal position, moved through an angle of 180 deg., and then swung back into its operative position facing the opposite direction. At the same time, the driving shaft for the shearing jib is transferred to the other side of the unit. The duplication of the gummer, loading bar and loading unit gear reduce the amount of work involved when preparing the machine for return cutting.

The "Dreadnought" universal arc shearing machine made by this company has been specially designed for heading work and is capable of cutting rooms up to 20ft wide. It is arranged for arcing at any angle from the vertical to the horizontal and will cut within a wide range of positions. The machine can be supplied either mounted on wheels for rail operation or with tracks for trackless running.

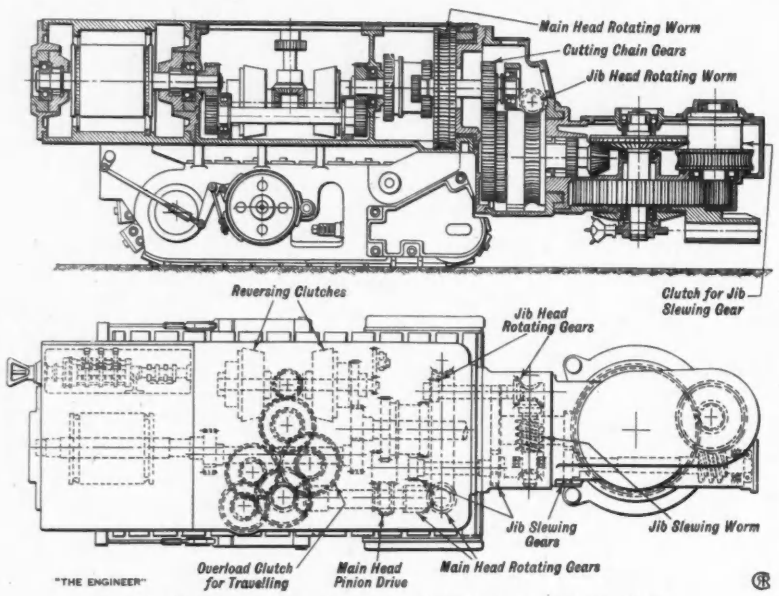


FIG. 27—UNIVERSAL ARC SHEARING MACHINE—ANDERSON BOYES

The general arrangement of the machine and its mechanism can be seen in the photographs and drawings we reproduce in Figs. 26 and 27. The gearhead is built in two sections consisting of the main head and the jib head. The main head can be rotated by a worm and worm wheel about the main axis of the machine. The jib head is mounted eccentrically on the main head and, through a second set of gearing, can be rotated about another axis parallel with the main axis of the machine. Each of the heads can be turned by power about its own axis, and they can be operated individually or simultaneously as required. By adjustment of the heads the cutting height of the jib in a horizontal plane can be set at any point from floor level up to about 5ft from floor level to the top pick. Shearing cuts over the same range can be made by similar adjustments.

When the machine is in operation movement is controlled by a master reversing clutch, through which any of the movements can be started, stopped or reversed. Safety clutches are employed on all motions to prevent overload. A push-pull lever is used to engage the gears required for either jib slewing or adjusting the position of the gearheads. The movement of this lever is controlled by a gate change mechanism, which allows the required gear to be selected and engaged without other motions being engaged simultaneously.

The jib is slewed through heavy spur gearing and two cutting speeds are provided to suit the nature of the work. In addition to a high flitting speed of 2 m.p.h. the rail-mounted machine is provided with an auxiliary flitting speed of 70ft per minute. This type of machine also has two sumping speeds of 4ft and 8ft per minute. The tractor-mounted machine has a similar range of speeds with a top flitting speed of 80ft per minute and an auxiliary flitting speed of 40ft. per minute.

M. AND C. SWITCHGEAR, LTD.

The electric control gear for coalface machinery shown by M. and C. Switchgear, Ltd., Kirkintilloch, Glasgow, includes the recently introduced type A435 room-switch shown in Fig. 30. This switch, which is rated at 80A, 660V, weighs only 210 lb and is so designed that all the cables leave the case in the direction of the roadway and not at right angles to it.

The equipment is enclosed in a robust cast case of light alloy, and all of the component parts within are readily accessible by the removal of the front cover. A start button and a stop/reset button are provided on the front cover. The 80A capacity continuously rated contactor is of particularly strong construction to withstand the heavy duty of mining service. An overcurrent relay of the magnetic type with dual time lags can be supplied for either hand or self-resetting. Enclosed within a separate flameproof chamber is a twin break isolating switch provided with auxiliary contacts which break the contactor coil circuit before the line contacts open. Optional fittings for the room-switch include an electromagnetic control relay and an air-cooled, single-phase control transformer.

Other products of interest on the stand

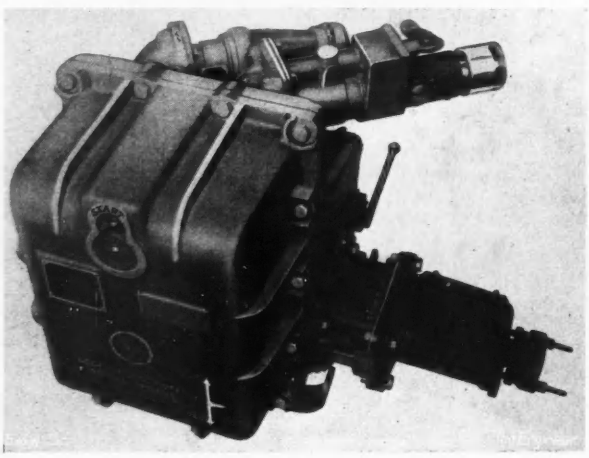


FIG. 30—ROOM SWITCH—M. AND C.

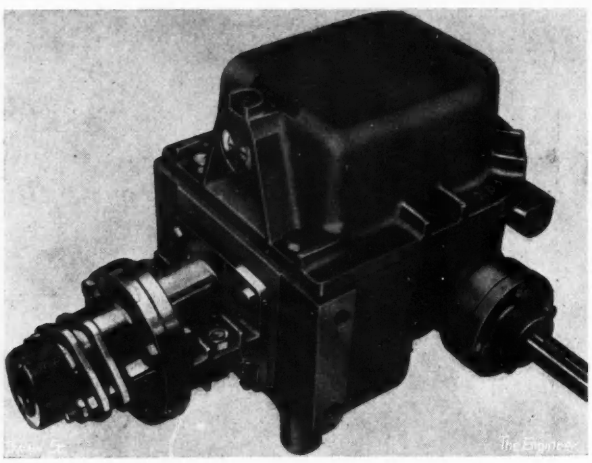


FIG. 31—CONTROL SWITCH—M. AND C.

includes the firm's "Sentryfugue" control and belt protection equipment for conveyors. Two separate pieces of apparatus are used—a control switch (Fig. 31) and a control relay (Fig. 32). The control switch is mounted in the conveyor frame and a driving wheel on its shaft transmits the belt speed to the switch mechanism. The control relay is contained in its own enclosure but when space permits it may be housed within the starter enclosure. When fitted, the switches and relays sequence

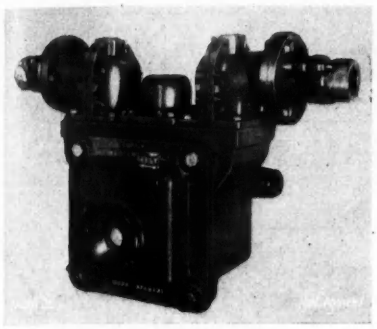


FIG. 32—CONTROL RELAY—M. AND C.

the speed of one conveyor to another or shut down a conveyor should belt slip or breakage take place.

The equipment can be arranged to provide three forms of protection: sequence operation in which the delivering conveyor can run only while the receiving conveyor is running above a predetermined speed; protection against belt slip or breakage in which the conveyor motor is stopped when the speed of the belt drops below a predetermined value, and a combination of both.

Sequence control is provided by one control switch driven by the belt of the receiving conveyor and controlling the operation of the delivering conveyor. Belt protection is provided by one control switch driven by the belt of the conveyor to be protected in conjunction with one "Sentryfugue" control relay, which controls the conveyor starter. When both sequence control and belt protection are required, sequence is provided by one control switch and belt protection by one control switch and one control relay, installed as described above.

When the relay is used on an installation in combination with the switch the relay allows the conveyor to run up to a predetermined speed when the switch automatically takes control. Normal stopping of the belt by means of the conveyor starter allows subsequent re-starting, but should the speed of the control switch drop through belt slip or breakage, the control relay shuts down the starter and makes a re-start impossible until the relay is manually reset. An indicator is provided on the control relay to indicate when belt slip has caused a stoppage.

(To be continued)

The Institution of Naval Architects

SUMMER MEETING IN EDINBURGH

No. II—*(Continued from page 39, July 8th)*

THE Summer Meeting of the Institution in Edinburgh was resumed Wednesday, June 29th, with the President (Admiral of the Fleet, Viscount Cunningham) in the Chair. The first paper to be presented was by Professor Georg Vedeler, and was entitled "Calculation of Beams."

In the discussion which followed, Mr. E. C. B. Corlett said that the Hardy-Cross method was simple and was very quickly and easily understood. But Professor Vedeler was correct in saying that it applied only to simple structures. In the case of a ship of more than one deck, if one tried to evaluate end fixity by the Hardy-Cross method the problem became very complicated, and the result was nothing like so good as that given by Professor Vedeler's method. However, a point to be remembered was that many people were familiar with the Hardy-Cross method and might not have time to adopt new variations. In the course of his further remarks, Mr. Corlett drew attention to the importance of "side sway," a term employed by civil engineers in connection with portal frames when under the influence of forces which were not symmetrical about a centre line.

Mr. W. Muckle endorsed Professor Vedeler's remark in the paper that naval architects ought to consider what might seem to be more complex methods of dealing with structural problems if they were really to make much progress in that sphere. It was assumed by Professor Vedeler that the joints themselves were rigid—and that was fundamental to the Hardy-Cross method as well. But one wondered whether that was absolutely true, whether even the best bracketed joint that we could make would ensure that the angle between the tangents of the two members did not change under load. If that change did occur it would, of course, introduce a further complicating factor into the analysis.

Professor E. V. Telfer said he felt that in the paper there was a hint of a challenge to the Classification Societies to use the more modern methods of structural analysis which were now available from aircraft development.

Professor Vedeler, in a brief reply, said that whilst he was quite willing to look into the question of side sway, which was very important, he did not like to complicate the present paper. He felt that when one first saw the method it was perhaps best to see the simplicity of it, and at a later date we might go a step further. It would be necessary to go further in order to get to the bottom of all such questions of ships' strength, and he hoped he might be able to make another communication in the future.

The next and final paper was by Mr. C. V. Manley (of Lloyd's Register of Shipping), entitled "A Fifty Years' Survey of Casualties to Merchant Ships reported Abandoned, Foundered or Missing."

DISCUSSION

Mr. R. B. Shepheard urged the necessity for realising precisely what types of ships were involved in the survey. The cases considered were only those of ships foundered, abandoned, or missing; the total losses due to strandings, collisions, fires and other similar causes had been ignored and, with the further elimination the author had effected of special types of ships, he had probably reduced his consideration to about 10 per cent of the total casualties of merchant ships under peacetime conditions during the period under review.

Referring to a table showing the total numbers of casualties of the types of ships dealt with over five-year periods, and the annual average losses in each of those periods, he said the figures showed a trend towards reduction of annual average losses. But there were two rather remarkable exceptions. In the period 1919-23 the annual average was of the order of 56, and the number of casualties in the five-year period was 283; both those figures were greatly in excess of those for the other periods. The second exceptional period covered the two and a half years which the author had been able to include since the second world war, 1946 to June, 1948). That period was only half as long as that to which the other figures related, and the annual average loss was about half that of previous periods.

It would be dangerous to draw too many inferences from those figures. But one was led to wonder whether there was something unusual in the period 1919-23. That was a post-war period; whether there were possibly war casualties in the figures for that period, whether there were casualties due to mine losses, lack of general maintenance due to war conditions, one did not know. But why did not the casualties show up in the same way for the period 1946-48?

From the statistical point of view, a table showing the proportion of casualties to total number of ships owned and to the gross tonnage owned was much more valuable. The overall picture showed a steady and general improvement. That table was a condensation of a much more extensive table given later in the paper; but from the statistical point of view there were obvious snags. For instance, he believed the figures representing the gross tonnages and the total numbers of ships in the analyses had not been corrected for the specialised types of ships which had been eliminated from the casualty lists by Mr. Manley, nor had they been corrected for ships laid up nor for ships undergoing repair and which, therefore, were not in normal service. That would make a considerable difference to the United States figures for the period 1946-48, for there were some 1900 of their ships in reserve rather than in service, amounting to about 12½ million tons; and some 3 million of the 18 million tons owned in the United Kingdom during that period were out of commission for re-conditioning or survey.

The possible causes of the losses of the ships might be broken down under several major headings; weather, human error (which was generally taken to include not only errors by personnel on board but also in the stowage and ballasting of the ships, defects in design, construction or maintenance of the ship or its machinery) and possible other risks such as fire; and there might be combinations of those possible causes. Again, in a diagram showing the ages of ships lost and a table indicating the ages of ships at the time of casualty, there was a tendency to higher losses (on the percentage basis) during the first five years of a ship's life than in the next two or three five-year periods. One could only surmise the reason, but it might be in some way related to the fact that the crews were working with something new, that they were not fully familiar with the peculiarities of loading, the behaviour at sea, even of the construction of the ships.

A diagram and figures in the paper indicated that, while the total number of losses

LOCOMOTIVE INTERCHANGE TRIALS ON BRITISH RAILWAYS, 1948—COAL CONSUMPTION

TABLE I.—*Express Passenger Engines*

Engine class		W.R. "King," 4–6–0		E.R. "A4," 4–6–2				L.M.R. "Duchess," 4–6–2				L.M.R. converted "Royal Scot," 4–6–0				S.R. "Merchant Navy," 4–6–2			
Engine No.		6018		60033	60034	60034	22*	46236				46162	46162	46162	46154	35019	35017	35017	35018
Route		Paddington Plymouth	King's X Leeds	Paddington Plymouth	King's X Leeds	Euston Carlisle	Waterloo Exeter	Paddington Plymouth	King's X Leeds	Euston Carlisle	Waterloo Exeter	Paddington Plymouth	King's X Leeds	Euston Carlisle	Waterloo Exeter	Paddington Plymouth	King's X Leeds	Euston Carlisle	Waterloo Exeter
Train miles	Down	225·1	185·7	225·1	185·7	299·5	171·5	225·1	185·7	299·5	171·5	225·1	185·7	299·5	171·5	225·1	185·7	299·5	171·5
	Up	225·8	185·8	225·8	185·8	299·6	171·6*	225·8	185·8	299·6	171·6	225·8	185·8	299·6	171·6	225·8	185·8	299·6	171·6
Average speed, m.p.h.	Down	47·8 46·8	46·7 46·7	45·6 45·7	46·5 47·2	47·5 46·5	52·2 50·9	45·4 46·5	47·7 46·7	48·5 48·7	51·0 50·7	44·6 46·0	45·8 43·3	49·9 46·1	48·4 49·0	45·8 46·0	47·1 46·0	45·8 48·0	49·4 49·8
	Up	47·1 48·0	47·3 47·9	47·2 47·0	46·7 45·8	46·9 46·3	41·8† 47·0	45·5 47·2	46·7 47·7	49·0 47·8	47·6 47·5	45·7 46·7	44·3 47·7	46·6 45·0	46·7 48·5	47·6 46·1	47·1 47·9	46·6 43·8	49·3 45·3
Average d.b.h.p. (under power)	Down	711 780	830 854	763 752	750 737	833 886	789 664	674 690	866 846	867 847	723 679	593 632	849 757	743 733	655 673	764 730	797 766	822 912	769 743
	Up	704 699	693 712	832 892	759 728	867 800	917 790	721 764	813 729	838 835	738 765	753 742	769 763	691 697	772 796	779 753	706 708	834 795	866 781
Coal per train mile	Down	47·66 52·11	51·85 53·93	39·76 42·18	40·12 37·8	40·5 43·74	41·57 38·31	40·09 38·34	45·16 46·18	44·57 44·21	43·08 40·67	37·68 36·06	49·6 47·4	39·5 43·85	38·12 40·12	52·01 45·98	57·92 51·20	49·42 51·86	46·24 51·22
	Up	46·96 48·56	40·12 43·01	43·00 44·87	40·35 38·0	40·89 39·92	57·98 44·42	43·84 44·39	44·18 40·74	45·25 42·31	43·20 43·99	50·08 47·22	46·8 42·8	41·97 40·39	48·68 50·65	47·83 46·27	44·40 44·14	51·05 50·22	54·48 51·47
Coal per d.h.p. hour	Down	3·81 3·64	3·48 3·43	2·98 3·24	2·97 2·84	2·92 2·90	3·18 3·38	3·22 3·21	2·97 3·02	3·08 3·12	3·27 3·27	3·60 3·33	3·29 3·33	3·24 3·41	3·07 3·12	3·70 3·48	4·00 3·59	3·44 3·41	3·44 3·72
	Up	3·66 3·86	3·21 3·42	3·33 3·19	2·93 2·92	3·06 3·14	3·20 3·05	3·30 3·24	3·04 3·15	3·09 3·0	3·13 3·00	3·80 3·81	3·24 3·18	3·45 3·40	3·30 3·46	3·71 3·56	3·67 3·63	3·61 3·86	3·44 3·49
Evaporation, lb. water/lb. coal (actual)	Down	7·59 7·25	8·29 8·27	8·28 7·8	7·0 7·32	8·33 8·37	7·78 8·07	9·34 9·09	8·50 8·38	8·74 8·33	8·74 8·53	7·78 8·35	7·24 7·54	7·61 7·53	8·97 8·78	8·36 8·87	7·52 7·96	9·07 8·40	9·02 8·25
	Up	7·46 7·32	9·38 9·24	7·36 7·46	8·20 8·56	7·99 8·03	7·92 8·26	9·07 8·62	8·38 8·53	8·52 8·80	8·54 8·64	7·16 7·12	7·7 7·73	7·12 7·45	7·85 7·37	8·88 8·55	8·32 8·32	8·27 8·24	8·55 8·77

* On first up journey engine 22 failed and test terminated at Salisbury. Engine 60033 used on second down and second up journey.
† Exeter-Salisbury only.

TABLE II.—*Mixed Traffic Engines*

Engine class		W.R. "Hall," 4–6–0		E.R. "B.1" class, 4–6–0				L.M.R "5" class, 4–6–0				S.R. "West Country," 4–6–2			
Engine number		6990		61251	61163	61251	61292	45253	45253	45253	44973	34006	34006	34005	34004
Route		Bristol Plymouth	Marylebone Manchester	Bristol Plymouth	Marylebone Manchester	St. Pancras Manchester	Perth Inverness	Bristol Plymouth	Marylebone Manchester	St. Pancras Manchester	Perth Inverness	Bristol Plymouth	Marylebone Manchester	St. Pancras Manchester	Perth Inverness
Train miles	Down	127·3	206·1	127·3	206·1	189·9	118·1	127·3	206·1	189·9	118·2	127·3	206·1	190·0	118·1
	Up	127·3	206·1	127·3	206·1	190·0	118·2	127·3	206·1	190·0	118·3	127·3	206·1	190·0	118·2
Average speed, m.p.h.	Down	43·0 40·1	39·28 40·87	42·1 44·0	38·7 38·4	43·9 44·0	32·3 32·9	44·9 43·5	36·5 38·8	43·4 42·4	33·65 33·14	40·1 45·7	41·3 39·0	45·1 45·1	34·46 34·93
	Up	42·6 45·6	40·3 40·00	43·1 46·5	37·5 40·1	46·1 44·9	35·2 35·8	45·7 43·6	39·2 39·9	44·4 44·4	36·93 35·94	47·3 45·6	40·3 40·7	48·2 46·1	40·71 35·84
Average d.b.h.p. (under power)	Down	622 559	636 696	569 705	645 671	579 592	549 628	623 593	564 636	605 626	544 546	626 744	803 713	753 689	734 722
	Up	553 614	685 710	686 771	671 703	554 593	608 683	659 709	668 709	563 580	627 579	814 786	804 823	692 671	825 707
Coal per train mile, lb.	Down	54·68 39·04	49·88 47·66	41·25 50·37	40·95 42·81	32·71 34·29	49·98 51·92	37·86 37·98	38·91 39·44	38·50 40·12	43·87 52·87	47·98 49·27	52·47 50·25	46·04 42·81	66·12 64·22
	Up	45·67 48·24	45·07 44·34	47·99 48·18	42·82 40·65	33·98 33·84	45·21 51·01	38·59 42·42	40·09 43·55	36·41 37·61	48·27 48·12	62·22 52·42	48·15 50·27	42·67 41·79	63·48 59·15
Coal per d.h.p. hour, lb.	Down	4·56 3·43	4·28 4·04	3·83 4·14	3·41 3·35	3·31 3·50	4·21 4·04	3·36 3·28	3·31 3·27	3·86 3·70	3·63 4·09	4·05 3·90	4·07 3·92	3·74 3·74	4·80 4·80
	Up	4·21 4·24	3·62 3·48	4·17 3·71	3·36 3·18	3·37 3·21	3·83 3·95	3·44 3·48	3·18 3·39	3·64 3·65	3·93 3·93	4·90 4·26	3·71 3·88	3·89 3·84	4·70 4·77
Evaporation, lb. water/lb. coal	Down	7·21 9·16	7·06 7·16	8·33 7·29	7·95 7·71	8·35 7·87	7·12 7·17	8·01 8·19	8·21 8·10	7·50 7·70	9·39 7·89	8·86 8·57	7·71 7·94	8·83 8·87	7·08 7·39
	Up	8·15 7·15	7·68 8·00	7·71 6·76	7·65 7·99	8·17 8·62	7·11 7·05	7·53 7·33	7·95 7·51	7·86 7·74	7·99 7·96	6·74 7·63	7·99 7·62	8·75 8·93	6·66 7·42

had steadily decreased, again with the exception of the period 1919-23, the losses in the range of ships up to 200ft long had remained about the same. Conjecture came very much into the picture, but Mr. Shepheard suggested a reason might be the chance of heavy weather in conjunction with, possibly, human error and the development of some defects in the ships.

Mr. H. E. Skinner referred to the author's figures of casualties to ships according to their length, and said it would be helpful to know also the total numbers of ships existing in their different lengths. Roughly, however, ships of more than 400ft constituted about one-third of the ships of the world, those between 200ft and 400ft constituted one-third, and ships up to 200ft long represented the remaining one-third. For the group more than 400ft long the casualties were only 3·7 per cent of the total number, whereas in the group from 200ft to 400ft more than 50 per cent of the casualties occurred. That was a very significant difference and needed investigation. We ought, also, to try to separate out the number of passenger ships; although the author had stated that he was dealing with cargo ships, it was not quite clear whether he had excluded ships defined as passenger ships, i.e., those which carried more than twelve passengers. Mr. Skinner's reasons for raising the point was a statement on the stability of ships, circulated by the Ministry of Transport to the British delegation to the 1948 International Convention on Safety of Life at Sea. It gave the number of casualties during the period 1929-47; there were twenty ships which were thought to have been lost for reasons connected with stability. In that list there were no passenger ships, but there were nineteen cargo vessels of less than 400ft length and one cargo vessel above 400ft. It was significant that the risk of loss was affected by whether a ship was a passenger ship or was more than 400ft long.

One conclusion which he suggested could be drawn from the paper, and should be drawn by every naval architect, was that the present freeboard regulations were sadly in need of revision.

Mr. J. S. Ormiston, referring to the author's table showing ages of ships at time of casualty, said the total of casualties to ships in the age groups six to ten and eleven to fifteen years added together was as large as among ships in the age group twenty-one to thirty years; and the total in the age group eleven to fifteen years (a five-year group) was about half the number in the age group twenty-one to thirty (a ten-year group). Although one might infer that casualties increased with the ages of ships, that did not appear to be borne out; and it must be remembered that there had been improved construction in the more recent years.

Dr. S. Livingstone Smith endorsed the query raised by other speakers as to the safety of drawing conclusions from the figures unless they were corrected either for the numbers of ships in existence in their various lengths, or as regarded the cargoes carried; perhaps an alternative would be the total number of voyages made by the ships in the various categories.

Professor E. V. Telfer recalled the peculiarity of the increased number of casualties during the period 1919-23, and was rather in agreement with Professor A. M. Robb, who, in a written communication, had referred to scuttling as being possibly one of the factors having a bearing on the statistics for that period, because the increase was apparent in all sizes of ships, particularly those in the 100ft to 200ft group, and even among those more than 400ft long.

Another point of extreme interest was the frequency of the loss of new ships. He was not sure that he would agree to put the blame on the crews for not knowing how to handle new ships; after all, crews changed so frequently that every old ship was a new ship to its crew. There had been a criticism that we were not necessarily always able to produce a ship which was entirely stable; if there were lack of freeboard, that was something which the profession would know. If the lesson of the statistics was that the least qualified vessels would the more rapidly be lost, it would be valuable to know what actually had happened to the ships.

Mr. James More was not wholly in agreement with the comments made concerning the increased losses during the period 1919-23. Although the actual numbers of ships lost in that period were considerably above the average, he drew attention to the table in which the losses were given for the various periods as a percentage of the total number of ships owned. There the figure, 0·23 per cent, was no greater than the figures over the twenty-five years from 1889 to 1923. But he regarded as remarkable the steep rate at which the losses fell after 1919-23, and particularly in the present post-war period, which were only a quarter of those for 1919-23, and only half the figures for the period immediately preceding the last war. Additional information on the rate of casualties would be exceedingly interesting. Particularly, he would like to know what proportion of the lost ships were actually missing, there being no knowledge of what happened. The nature of the cargoes carried was clearly important, and it was remarkable that in these days of form-filling no less than one in eight of the casualties was listed as carrying cargoes not known; in the early 1930s the figure was as high as one in five.

Mr. Manley, in his reply, said that if the casualties covered in the paper could have been related to the types of ships, and so on, and if some of the information asked for could have been given completely, it would have been very informative. But the information was not available for the whole fifty years, and his aim had been to make an objective survey of conditions of which he had the relative information throughout the period. Particulars in the divisions of age, tonnage, &c., were available from 1924 onwards, and from a quick look through them it seemed that there was a surprising correspondence with the results given in the paper. However, in view of the discussion, he hoped to make some further researches.

With regard to the point that certain types of ships had been eliminated, he said that again there were no figures relating to them; but their tonnage was not appreciable in relation to the total tonnage.

In reply to Mr. Skinner, he said that possibly some of the ships had carried passengers; he had seen very few that were noted as passenger and cargo ships, and he had deduced that practically the whole of the ships subjected to casualty were ordinary cargo ships. Whilst the percentage of casualties of small ships, less than 200ft long, had increased in relation to the total casualties, over the period of fifty years the extent of the casualties among small ships had remained fairly constant, whereas for those of more than 200ft length it had decreased.

The President, at the conclusion of the discussion, defended the ordinary sailor against the accusation of scuttling ships as an explanation of the high casualty figures in the period 1919-23. Bearing in mind, in conjunction with those figures, that the Mediterranean and North Sea were high casualty areas, he would have thought the high losses were due to undisclosed mines. The reason why there was not a similar increase after the second world war was that the organisation for mine clearance had become a hundred times better than formerly.

(To be continued)

The Locomotive Interchange Trials of 1948

THE report of the Locomotive Testing Committee of the Railway Executive on the Locomotive Interchange Trials of 1948, to which brief reference was made in THE ENGINEER of July 1, 1949, is a remarkably comprehensive document running to more than 130 pages. Not only are such items of overall performance as coal and water consumption fully reported for each individual run; numerous notes on other matters of interest are included, such as irregularities in drawbar pull experienced with certain classes of engine, and the propensity for slipping to which other classes appear to be susceptible. But it is the coal consumption data that will most likely prove of the widest interest, and three tables have been prepared from a mass of information (Tables I and II opposite, and Table III overleaf).

It will be recalled that on each route the competing engines made two return trips, after preliminary runs to enable the visiting enginemen to gain some knowledge of the road. Data relating to every one of the test trips is given in the accompanying tables. The runs were made on ordinary service trains, and were liable to experience delays from engineering and traffic restrictions; and although the relating of coal consumption to the average drawbar horsepower maintained throughout the trip goes some way to compensating for different conditions existing on different runs, the tables are extended to show the average drawbar horsepower, and perhaps more significantly, the coal consumed per train mile, which showed considerable variation from trip to trip. The overall figures, interesting as they are, do not tell more than a part of the story. To take one particular example, from Table II, one is naturally curious to know how the driver of the Western Region "Hall" class 4–6–0 No. 6990 on two successive trips from Bristol to Plymouth brought his coal consumption down from 54·68 lb to 39·04 lb per train mile, and the coal per d.h.p. hour from 4·56 lb to 3·43 lb. But on close study, the tables will be found to contain many other points that appear baffling, till one recalls the striking day-to-day variation that has been recorded in past trials, with other locomotives, not only burning their accustomed fuel and running over the routes for which they were specially designed, but

LOCOMOTIVE INTERCHANGE TRIALS—COAL CONSUMPTION OF FREIGHT ENGINES

TABLE III.—*Freight Engines*

Engine class		W.R. "2800" class, 2–8–0		E.R. "O1" class, 2–8–0			L.M.R. "8F" class, 2–8–0			"Austerity," 2–8–0			"Austerity," 2–10–0		
Engine No.		3803	3803	63773	63773	63789	48189	48189	48189*	77000	63169	63169	77000	73774	73774	73776	73774
Route		Acton Severn Tunnel Jc.	Ferme Park New England	Acton Severn Tunnel Jc.	Ferme Park New England	Brent Toton	Acton Severn Tunnel Jc.	Ferme Park New England	Brent Toton	Acton Severn Tunnel Jc.	Ferme Park New England	Brent Toton	Bristol Eastleigh	Acton Severn Tunnel Jc.	Ferme Park New England	Brent Toton	Bristol Eastleigh
Train miles	Down.....	118·9	74·1	118·9	74·1	127·0	118·8	74·1	126·8	118·9	74·1	127·1	76·4	119·3	74·1	126·35	76·65
	Up	116·75	73·9	116·95	73·4	127·8	116·25	73·6	127·5	114·0†	73·4	128·0	75·6	116·3	73·4	127·85	75·58
Average speed, m.p.h.	Down...	21·94	22·9	17·21	23·8	21·2	20·41	26·5	22·4	19·76	26·2	19·7	19·2	20·3	27·2	21·6	18·9
		20·31	24·2	20·27	23·2	21·4	20·90	26·2	21·5	20·57	26·1	22·7	19·1	19·7	25·7	20·2	18·73
	Up ...	18·02	20·5	18·24	18·0	14·6	17·91	18·7	14·4	17·24	17·3	17·4	21·6	17·4	22·0	14·9	20·87
		17·01	20·6	18·23	17·9	17·4	17·22	20·1	15·8	16·06	16·3	15·6	19·4	18·1	19·2	15·1	22·21
Average d.b.h.p. (under power)	Down...	416	415	392	546	488	465	505	575	463	405	512	422	415	590	544	486
		454	607	516	521	536	390	515	596	471	426	425	435	405	486	505	527
	Up ...	345	605	419	474	534	349	478	498	523	331	436	449	392	576	498	528
		332	628	377	417	536	343	514	518	455	341	429	434	380	535	490	499
Coal per train mile, lb	Down...	54·04	51·5	58·1	61·7	68·1	61·8	51·2	78·19	71·99	65·0	56·8	80·2	72·97	55·4	56·6	78·12	75·93
		64·13	72·3	59·0	64·8	73·0	54·8	52·3	79·00	67·30	59·5	47·1	69·1	79·38	53·8	50·3	70·41	70·86
	Up ...	57·84	73·2	53·7	62·9	84·0	59·3	66·7	91·83	65·04	67·5	72·8	84·4	59·34	61·9	61·2	87·12	69·72
		55·35	74·0	55·9	60·5	73·0	60·3	62·3	79·70	61·93	75·1	79·0	82·4	75·65	55·9	72·7	86·45	59·81
Coal per d.h.p. hour, lb	Down...	3·64	3·09	3·83	3·11	3·32	3·86	2·98	3·41	3·97	4·01	3·09	3·46	4·45	3·75	2·80	3·50	4·27
		3·57	3·05	3·40	3·26	3·24	3·80	2·91	3·14	3·69	3·76	3·07	3·46	4·68	3·59	2·80	3·33	3·68
	Up ...	3·52	3·35	3·22	3·17	3·29	3·71	3·46	3·76	3·33	4·16	3·83	3·6	3·26	3·56	3·24	3·74	3·27
		3·43	3·50	3·27	3·46	3·37	3·86	3·29	3·61	3·32	4·14	4·13	3·67	4·03	3·47	3·49	4·01	3·40
Evaporation, lb. water/lb. coal (actual) ...	Down...	7·38	8·72	8·05	7·40	8·20	7·63	7·79	7·06	8·43	7·47	7·23	7·85	7·81	7·85	8·08	7·68	8·36
		6·93	7·25	8·79	7·49	7·70	7·35	7·85	7·94	8·27	7·88	7·60	7·98	7·46	8·62	8·32	8·00	8·77
	Up ...	7·48	7·45	9·43	7·79	7·87	7·71	7·72	7·59	7·46	7·62	7·71	7·23	7·45	8·73	7·91	7·49	8·86
		7·93	7·35	8·77	7·49	8·03	7·46	7·50	7·44	7·30	7·59	7·81	7·32	7·70	7·80	7·23	7·66	9·07

* Engine 48400 used on first down and first up test on this route.

† On the second up journey test terminated at Iver.

also in the hands of regular crews, who would be familiar with the peculiarities of individual engines.

Particular interest is attached to the work of the Western Region engines using hard coal. The properties of the various coals used are set out in Table V. The report states that the "King" class engine, No. 6018, steamed freely on a fuel having characteristics widely differing from that normally used on engines of the Western Region, though the consumption in pound per d.h.p. hour was above the figure normally obtained with Welsh coal. As will be seen from Table I, there was considerable variation between the north-bound and south-bound runs of this engine on the King's Cross-Leeds route. So far as coal consumption is concerned, the consistently good record of the Gresley streamlined "Pacifics" of class "A4" cannot fail to be noted, though it must also be remembered that the world record-holder, "Mallard" (engine No. 22), failed twice with a heated middle big-end, once in preliminary running on the Western Region, and again on the first up test run with the Southern Region "Atlantic Coast Express."

The coal consumption figures for the smaller Southern Region "Pacifics" of the "West Country" class appear to be high, even when related to the actual work done. But the power output of these engines was, at times, altogether extraordinary, and indeed provided some of the most spectacular performance of the whole series of tests, with drawbar horsepower figures rising to 2000 (with a locomotive having only 31,000 lb nominal tractive effort). A point to be noted from Table II about the test results obtained from these engines was that the coal consumption per d.h.p. hour tended to increase with the power output, whereas the opposite characteristic is more usual. It should also be noted that on the down runs over the Highland line all the competing engines were provided with banking assistance up the long incline from Blair Atholl to Dalnaspidal, though from a study of the working elsewhere the Bulleid "Pacific" might well have dispensed with such assistance.

The report makes considerable reference to the slipping of certain engines; but while the factors of adhesion are quoted, together with the relevant atmospheric conditions, no attempt is made to relate this tendency to slipping to the mechanical design of the locomotive itself. A portion of the dynamometer car record, taken during a Paddington-Plymouth run with a "Merchant Navy" class engine, is reproduced in the report to show the effect of partial slipping, continued for 2¼ miles, in the ascent of the Rattery incline, west of Totnes. At the time, the speed was varying between 26·8 and 36 m.p.h., the rails were dry, and the ratio of drawbar pull (referred to level track) to adhesion weight varied between 0·104 and 0·118. The cut-off was 25 per cent and steam chest pressure between 210 lb and 250 lb per square inch. Sand was not used until the last half mile of this period of slipping. The London Midland "Duchess" class "Pacific" is reported as having slipped almost to a standstill in the east-bound ascent to Dainton Tunnel on the first up journey of the test week.

A very interesting section of the report gives selected examples of high-power output by the various engines, though the Committee is careful to say that these examples should not be considered in the light of comparisons between the competing locomotives. A few of these examples are quoted below. Both "recorded" and "equivalent" values are given for pull and drawbar horsepower. The

equivalent figures have been calculated to show the pull and drawbar horsepower the locomotive would be exerting on level track at constant speed, allowance having been made for the effect of gradients and acceleration or retardation, on the mass of the locomotive and tender. As the various examples of performance were taken on stretches of line having different gradients, this quoting of "equivalent" values reduces the records to a common basis. In the accompanying Table IV, a single example has been chosen for each of the classes of locomotive engaged, and the actual output of power quoted requires consideration alongside the details of regulator opening, cut-off, and so on.

Another section of the report gives details, necessarily very brief, of the engine working throughout the various test runs. From these details it appears to have been rare for any of the competing passenger engines to be run for any length of time with a full regulator opening. The Western Region "King" class engine on its own road was, according to the report, "mainly worked in 17 per cent cut-off on the first valve of the regulator, except on the steeper banks. Maximum running cut-off used was 50 per cent with the second valve one-quarter open." The Gresley "Pacifics" were run with steam chest pressures varying between 150 lb and 230 lb per square inch, averaging about 200, with cut-offs varying between 15 and 20 per cent. Both the "Pacific" and "Royal Scots" of the London Midland Region were run in very similar style, though with the "Royal Scots," having considerably the lowest nominal tractive effort of all the express passenger engines, rather wider regulator openings were used at times. The "Merchant Navy" class engines of the Southern Region were generally worked in about 25 per cent cut-off, with steam chest pressures well below 200 lb per square inch. There seemed no disposition on the part of drivers to link up below about 15 per cent, except on the London Midland engines, which had periods of 12 per cent. Reports on the running on each of the test routes showed also that in general all the competing engines steamed well, though some bad patches were recorded, and occasionally cases of waste of steam through over-firing. To render conditions similar for all engines, those classes fitted with continuous blow-down had the apparatus rendered inoperative.

TABLE IV.—*Example of Engine Performance*

Engine		Route Location	Reg'n	Gradient (rising)	Speed, m.p.h.	Recorded		Equivalent		Cut-off, per cent	Boiler pressure, lb/sq in	Regulator
Region	Class					Pull, tons	D.h.p.	Pull, tons	D.h.p.			
Western ...	"King"	Wrenthorpe	E.	91	34·2	5·69	1162	7·28	1480	35	240	¼
Eastern ...	"A4"	Chard Junction ...	S.	140	45	4·4	1182	5·6	1505	30	215	205 S.C.P.
L.M.... ...	"Duchess" ...	Shap incline	L.M.	75	42·4	4·95	1252	5·95	1506	36	233	¼
L.M.... ...	"Royal Scot"...	Lavington	W.	222	61	3·85	1402	4·47	1630	25	235	¼
Southern...	"Mer. Navy"...	Honiton Bank ...	S.	90	33	6·0	1182	7·4	1460	40	270	190 S.C.P.
Western ...	"Hall"	Springwood	E.	100	32·1	5·24	1004	6·47	1240	45	220	⅜
Eastern ...	"B1"	Wellington Bank...	W.	175	47·0	3·95	1107	4·66	1336	30	225	205 S.C.P.
L.M.... ...	Class "5" ...	Cullompton	W.	155	56·0	3·3	1105	4·18	1398	35	214	¼
Southern...	"West Country"	Whetstone	E.	176	67·8	4·12	1667	4·97	2010	27	260	240 S.C.P.
Western ...	"2800"	Potters Bar	E.	200	21·5	7·3	937	8·0	1028	39	218	⅜
Eastern ...	"O1"	Hullavington ...	W.	300	21·1	8·24	1038	9·13	1152	45	220	Full
L.M.... ...	"8F"	Manton	L.M.	142	22·5	6·7	900	7·7	1041	34	217	Full
Austerity ..	2–8–0...	Manton	L.M.	167	26·0	5·3	825	5·8	898	35	225	⅜
Austerity ..	2–10–0	Irchester	L.M.	526–200	29·5	5·2	916	5·7	999	34	215	¼

S.C.P.=steam chest pressure.

TABLE V.—*Properties of Coals Used*

Grade	South Kirkby (dried)	Blidworth (dried)	Comrie (dried)	Abergorki (dried)
Volatile matter less moisture, per cent	36·0	34·2	36·8	15·5
Fixed carbon, per cent	60·6	60·9	55·2	80·3
Ash, per cent	3·4	4·9	8·0	4·2
Total sulphur, per cent	0·75	0·65	0·60	1·58
Gross B.Th.U. per lb.	14,400	13,910	13,300	15,030
Gross B.Th.U. per lb. Mean of a number of samples	14,400	13.940	13,300	15,100

TABLE VI.—*Coal Consumption of Western Region Engines Working on Different Grades, between Paddington and Plymouth (Kings), and Bristol and Plymouth (Halls)*

	South Kirkby (original tests)	Abergorki coal (additional tests)	Abergorki (South Kirkby equivalent)
"King" class (No. 6001) (low superheat):			
Pounds per train mile	48·82	42·28	44·33
Pounds per d.h.p. hour	3·74	3·33	3·50
Pounds per square foot of grate area per hour (running time)	67·5	59·6	62·6
"King" class (No. 6022) (high superheat):			
Pounds per train mile	—	41·23	43·23
Pounds per d.h.p. hour	—	3·10	3·25
Pounds per square foot of grate area per hour (running time)	—	57·7	60·5
"Hall" class (No. 6961):			
Pounds per train mile	46·91	36·24	38·0
Pounds per d.h.p. hour	4·11	3·22	3·38
Pounds per square foot of grate area per hour (running time)	74·5	58·0	60·8

The properties of the various coals used in the trials are given in Table V. "South Kirkby" was used for the express passenger and mixed traffic trials in England, and "Blidworth" for the freight engine trials. In the trials on the Highland line, the coal used was "Comrie." The Western Region locomotives had grate and smokebox arrangements specifically designed to suit Welsh coal and these, together with the firing technique to which the Western Region enginemen had been trained, differed from what is customary with the types of coal used on the trials. In view of these conditions, it was arranged that, on completion of the trials, additional tests should be carried out on the Western Region using Welsh coal. The grade used was "Abergorki." Another feature of Western Region locomotives is the use of a relatively low degree of superheat. Since 1944, trials have been in progress with higher degrees of superheat on various standard Great Western locomotive classes, and opportunity was taken during this supplementary series of tests to include a "King" class engine, No. 6022, which is fitted with a large superheater.

These supplementary trials showed a considerable reduction in coal consumed per d.h.p. hour, with "Abergorki" as against "South Kirkby" coal, though some of this is due to the higher calorific value. In the Table VI, an "equivalent" consumption is shown in column three, making allowance for this difference. The most striking difference occurred with the "Hall" class engine, though it should be pointed out that in the supplementary trials, the locomotives used were not the same ones as in the interchange trials. The performance of the "King" class engine, with higher superheat, showed a slight improvement over the standard engine, though not more than might be accounted for by other variable factors inevitably present in road testing of locomotives.

The Report of the National Coal Board

(Contributed)

THIS report, which is submitted to the Minister of Fuel and Power in accordance with the provisions of Section 54 of the Coal Industry Nationalisation Act of 1946, and the Accounts in accordance with the provisions of Section 31 of that Act, and which was placed before the House of Commons on June 22nd, is the third annual report of the N.C.B. and covers the second year of the coal industry under public ownership, namely, the year ending December 31, 1948.

It is a voluminous document, embracing with the appendices no less than 299 pages of interesting matter relative to the Board's multifarious activities; for we learn therefrom that not only do these activities relate to the administration of the collieries and publicly owned coal, the coke ovens and briquette works—which are ancillary thereto—but to brickmaking—for they operate eighty-four brickworks and two pipeclay works—also to land and house property. The land, inclusive of that occupied for colliery purposes, farms and miscellaneous land—freehold and leasehold—amounts in total to 348,000 acres. The house property, again freehold and leasehold, numbers 167,407 houses. In fact the value of the fixed assets, according to the balance sheet (see Schedule 1 (*a*)) as at December 31, 1948), (subject to the addition of amounts not yet known), was no less than £270,825,013.

Financial Results

As coal is a wasting asset the annual operating profit should not only be sufficient to permit of the payment of a fair dividend to the investor—in this case the British public (in that such profit should go to the mitigation of income tax) but allow for amortisation. So far, since the mines were nationalised, these desiderata cannot be said to have been attained. For though an operating profit (before deduction of statutory charges in respect of capital provided by the Minister of Fuel and Power) of £17,514,956 was realised (or a net profit after deduction of interest and interim income payable to the Ministry of £1,651,965) as against the comparative figures of losses in respect of 1947, namely, £6,187,300 and £23,255,586, the profit was earned under abnormal conditions of selling prices, especially in respect of exported coal. Indeed, the operative profit was almost entirely due to the premium earned in respect of exported coal—conditions which are unlikely to be of long continuance, for the European coal famine has ceased and foreign competition is becoming keener. Profits made by the National Coal Board not being subject to deduction for income-tax, the Treasury does not reap the handsome annual revenue from the coal industry which it obtained in the days of private enterprise.

Selling Prices, Costs, Production and Absenteeism

The outlook is therefore dubious; selling prices both inland and export have reached a figure which cannot be maintained. The inland price is two and a half times the pre-war figure, the average price for such coal having been increased with flat-rate additions of about 26s. a ton since before the war. As to exported coal, at the end of the year, price varied according to quality from nothing to over £1 a ton above inland prices for the same coals.

Inclusive of coal supplied to ships' bunkers, we are informed that 16,000,000 tons were shipped (compared with 5½ million tons in 1947) (of this quantity it would be interesting to know what was the amount actually exported), as against the comparative figure of 52,000,000 tons for the year 1937.

If Britain is to continue to expand her export trade in coal, prices will have to be reduced in the face of foreign competition; and, seeing that coal is the chief source of heat, light and power in Great Britain and figures largely in the production of many manufactured commodities, cheap inland coal is just as essential.

As Sir Charles Reid stated in the discussion following the reading of his son's paper on "The Reconstruction of the British Mining Industry," before the Royal Society of Arts on March 16th of this year: "On the question whether we shall be able to compete with our competitors, I should like to point out that Poland, which was our biggest international competitor before the war, is now a closed book to us all; but it is a good guess that she is now producing very much cheaper than we are. Whether that competition will affect our markets in the future is not for me to say, but I do believe that a bigger reduction than five shillings in the price of coal within fifteen years will be necessary if we are to hold our markets."

The cost of producing a ton of coal in 1938 was 16s., at the close of 1948 it was 46s. (During 1948 there was a rise in costs of 4s. 8d. a ton, due mainly to large wage increases—amounting to £62½ million in the year—granted in the year 1947.) As *The Times*, in a leading article in its issue of June 23rd of this year, put it: "the rise in price during and since the war has been wholly out of harmony with the country's urgent and growing need to lower its industrial costs." But what is the solution? How can costs be lowered? This the Board must set about doing and doing it now, if the country is to hold its own in the markets of the world. It is by far and away their major problem. Again quoting from *The Times'* leading article already alluded to: "The justification advanced for setting up the present national organisation was precisely that it offered the best means of introducing those far-reaching changes which were needed to put British mining on a competitive footing by world comparison. This is the first test of public ownership," and, as indeed is stated in the introduction to the report, "to produce more coal, to improve its quality and to curb costs were the most pressing needs of 1948." The output target of a minimum of 200 million tons was not realised, however, 197,645,700 tons only being obtained, as against 187,202,800 tons in the previous year.

From the evidence forthcoming from the report and from the paper compiled by Sir Charles and Dr. William Reid, already referred to, there appears to be little prospect of relief in reduced production costs in the near future. Such relief would seem to be the outcome of a long-term policy, if at all.

Wages contribute about two-thirds of the total cost of production. "Before the war," says the report, "miners' wages were low in relation to other industries; now miners are paid more than most other workers," which is true. But in "boom" years they made very high earnings. "Average earnings per shift (inclusive of the value of allowances in kind) went up from 11s. 8d. in 1938 to 33s. 2d. in 1948." That is to say, the average of all workers—surface and underground. But the average of persons employed at the face would considerably exceed these figures and the increases in wages and prices of materials were not balanced by improved productivity. It was not until 1948 that the pre-war standard of productivity as measured by output per manshift was regained, but there should be no complacency felt therefrom, for, logically, all the increases in labour-saving and labour-aiding appliances carried out during recent years at the mines should have been reflected in a very marked and steady enhancement in output per manshift; but such has not been the case and the disagreeable and discouraging fact must be faced that, from whatever cause, the miners are not, as a whole, working as hard as they used to do before the advent of mechanised mining at the coalface—for there has been no sudden change to less favourable natural conditions—and that the receipt of higher wages has been followed by the extension of abstention from regular daily attendance at work. Absenteeism is far too high; for all workers the average for 1948 was 11·55 per cent (in the Midlands it was as high as 14·84 per cent), as against 12·48 per cent in 1947. In 1939 it was only 6·44 per cent. It should be borne in mind, too, that the increase is not due to the fact that the average age of the workers now employed at the mines is higher than in pre-war days due to the younger men having drifted into other industries or to employment in the fighting forces, for, as the colliery managers are well aware, the older are the more regular attenders at work. It would appear that the miner works to earn sufficient to meet his wants and during a period in which high wages rules the requirements of the younger and unmarried man are more easily satisfied than in times of low wages. A higher output, even apart from an enhancement of productivity per manshift, at the face, obtainable by more regular attendance at work of the face-men, would tend towards a reduction of the cost per ton, as the cost of the "offhand" work would be spread over a larger tonnage without a corresponding increase in the numbers of datailers. The Board could also make a contribution by cutting down administrative costs. One method of doing so would be by leaving more of this in the hands of the colliery managers, the Board contenting itself with the framing of general policy and matters of general principle—in fact, in more decentralisation as regards management. The advantages of centralisation are many and obvious but in some matters, especially in those in which quick decisions are essential, are dangerous and costly.

Coal Preparation

That the increase of the dirt contained in the coal now being delivered from the collieries is due to the higher proportion of mechanically got coal, which would appear to be the view put forward by the report, will not, one is inclined to think, be accepted generally as entirely explanatory by the colliery managers, for after all the difference in quantity so obtained now compared with that won in like manner before the war is small, yet

the dirtiness is a matter of recent complaint.

Dr. William Reid stated, in the discussion of the paper already referred to, that "in some parts of the country we are producing too large a percentage of low-grade steam coals and unfortunately some of this is finding its way into the household market." But the complaints are by no means restricted to householders but emanate from consumers of industrial coal also. The advent of opencast coal in the market is probably the chief cause of the enhanced impurity of the coal.

Labour

As the report states, in neither 1947 nor in 1948 were there any what are termed "official" strikes, but in 1948 there were no less than 1528 unofficial strikes, involving 190,915 men, with a consequential loss of output amounting to 1,062,300 tons of coal, which points to a lack of control on the part of the National Union of Mineworkers. Nor does the conciliation machinery, which exists, appear, as it should have done, to have met the situation; though it must strike every fair-minded person who studied the report to be so framed as to have done so. The scheme consists of three parts, namely, a National Conciliation Scheme (there is a Joint National Negotiating Committee of the Board and the Union, and there is a National Reference Tribunal, of which Lord Porter is President, to give decisions when the two parties cannot agree), and there is the District Conciliation Scheme—which two schemes were in existence before the mines were nationalised. To which has been added recently the Pit Conciliation Scheme. Can it be that failure to secure the end sought to be achieved by this machinery is due again to too much centralisation, resulting in a delaying effect on local management? Could not many of the troubles and misunderstandings arising at the collieries be prevented if the local management had freer hands as in the days of private enterprise? One wonders. It is an aspect of the case which should, however, be inquired into. The present high rate of wages has been mentioned and no fair-minded person will begrudge the miner his well-earned rate of remuneration but he must help to improve the situation by more regular attendance at work, and, indeed, in so doing help himself. To raise more coal without an increase in wages, that is the part he must play, otherwise there is disaster ahead both for himself and the nation. There is no getting away from the fact.

As to hours of work, it was agreed by the Board and the National Union of Mineworkers to continue the Extension of Hours Agreement until April 30, 1949. This agreement, which it will be remembered, provided for working an extra half-hour a day or, alternatively, for a Saturday shift, is known as the Five-Day Week, and came into being in May, 1947. This arrangement has not proved to be the success hoped for in increasing output, for, as the report states, the net gain may have been "7,000,000 tons." Difficulties arose in respect of the payment of the guaranteed wage for the extra Saturday shift. The Tribunal decided that payment of this wage does not depend on attendance from Monday to Friday, so there is an inducement to absenteeism during the week, or rather, there is no inducement to regular attendance. Nor does the bonus payable if the miner works his full shifts during the week have much effect in the reduction, for only the five normal shifts are taken into account in calculating the hours of a piece-worker who worked week-end shifts at day-wage rates.

Mining Engineering

Under this heading are included in the report such important matters as "Machinery at the Coalface," "Roof Control," and "Underground Transport." As it correctly indicates, the power-loading machinery for application at the coalface, the use of which has gone ahead so strikingly in the United States of America, is designed more for the "pillar and stall" method of working so prevalent in that country, whereas, owing to differences of natural conditions existing in the British coalfields, the method of working is chiefly that known as the "longwall," so that the American type of machine is not suited to British conditions, except in a comparatively few cases. But it might be added that the higher average thickness of the coal seams in the United States is also an item of deciding importance. The Meco-Moore cutter and self-loader is referred to as a British type of loader, which is doing good work, but there are several other mechanical loaders of British design eminently fitted to longwall working and use in thin seams, the use of which should be encouraged.

With regard to "Roof Control," whilst such interesting subjects as "pneumatic storage" of wastes and the use of hydraulically-operated props, and several other matters are referred to, no mention whatever is made of roof support with suspension rods.

As the report states (para. 130, page 28): "Falls of roof are still the commonest cause of accidents. The way to reduce these is to improve the conditions at the coalface by better 'roof control.' The Board continued their efforts to raise the standard of roof control throughout the coalfields." There is no reference to suspension rods, which is the more remarkable in view of what is being done in the United States, where the States Bureau is sponsoring this method through its Roof Control Group of the Health and Safety Division, and gives advice to anyone interested. At the American Mining Congress Coal Show, which recently took place at Cleveland, Ohio, the Bureau of Mines had a booth where models and photographs were exhibited, and a small leaflet was distributed. In this leaflet it is stated: "It is estimated that this type of support has been installed in approximately 50 miles of mine passages during the past two years, where some of the roof conditions in the country are most difficult. Personnel of the Bureau have kept in very close touch with all these installations and to date not a single lost-time accident from fall of roof has been reported from areas where the supports were installed." The method of support under review eliminates the use of props, most of which, in the case of Great Britain, are imported.

The Mining Congress *Journal*, of June, 1948, also has an interesting article, entitled "Roof Support with Suspension Rods," and a sub-heading, "Coal-mining may under certain conditions effect increased safety and economy in supporting bad top by using the roof bolting practice described." This revolutionary system of roof support should, if proved efficient and practicable, have remarkable repercussions on the coal-mining industry.

With regard to underground transport, it is interesting to note that by the end of the year, 185 locomotives were at work, of which 170 were diesels and fifteen electric-battery locomotives. But the wide use of this type of haulage is limited by two important factors, the necessity of level roads, which is not a characteristic of the British coal-mines, and the danger from sparking in gassy mines.

Conclusion

The exigencies of time and space prohibit the critical survey of many of the matters referred to in this copious report, only those which appeared to the present reviewer to be of major importance being dealt with. As to the future prospects of this great industry, upon the success of which the national productive effort is so dependent, one forbears to prognosticate. It is a case of "wait and see."

Obituary

ERICH KOCHER

It is with deep regret that we have received the news from Shanghai of the death, in April last, following a long illness, of Mr. Erich Kocher, who for many years was director of the Siemens China Company, and from 1931 until 1938 was the managing director of Siemens Schuckert (Great Britain), Ltd., London.

Mr. Kocher, who was in his sixty-eighth year, was born at Gavelsberg, in Westphalia, and after completing his technical training and his workshop practice with the A.E.G. and Felton Guilleaume Companies, entered in 1911 the service of Siemens-Schuckert-Werke, Berlin. After a short time in the foreign section, he went out to China as first engineer in the main office of the Siemens China Company in Shanghai. He remained with that company until 1929. In 1920 he was made a director and during those years he did much for the electrification of Chinese industry. He built and equipped tramways and power stations and designed and constructed the 30,000-V transmission line between Shanghai and Nanking. He also carried out the building of the Amoy water works, including the reservoir and dam. During the first world war Mr. Kocher remained in China and built for the Chinese authorities a prototype 5-ton blast-furnace, which at the end of the war was followed by a 50-ton blast-furnace with rolling mills for the production of reinforcement steel for concrete work. In those years he gained the confidence of many Chinese engineers and was adviser in the building of sugar refineries, textile works and electricity undertakings.

In August, 1931, he was appointed to London as managing director of Siemens Schuckert (Great Britain), Ltd., a position he occupied until the spring of 1938, when he retired from Siemens and started on a world tour, visiting his friends in Shanghai in the capacity of consulting engineer. His work in England included the installation of many electric furnaces for the production and refining of alloy steels, and the supply of electric boilers. On the civil engineering side he introduced the Siemens Bau-Union method of relieving water pressure by pumping, which was used in the construction of the large King George V graving dock at Southampton and methods of chemical consolidation which were employed in the construction of London Tubes and the Ford works at Dagenham. Mr. Kocher made friends in Britain and his death in China, the country he served so well for so many years, will be deeply regretted by those who were privileged to know him and work with him.

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

For Subscription Rates see page 2 of Advertisements.

THE LOCOMOTIVE EXCHANGES

FEW recent events in the railway world have created more interest than the Locomotive Exchanges of 1948. From the very first announcement of the scheme rather more than a year ago, the workings were keenly followed equally by locomotive men and by the host of enthusiasts, engineers and laymen alike, over whom the steam locomotive continues to cast its spell. Runs were timed in great detail and accuracy by outside observers travelling as passengers in the trains on which dynamometer car trials were conducted—indeed, one such observer, a retired railwayman, travelled thus over 10,000 miles behind locomotives on test. After the trials were completed items of information other than mere running times began to circulate, and some of these formed the basis of controversy in our own correspondence columns. All this testified to the eagerness with which full results were awaited. During the months that have elapsed since the completion of the trials a great deal of information has reached us from various sources; but this, though doubtless accurate, and interesting in itself, did not appear of any great consequence without the broader picture presented by the data collected in the dynamometer cars, and contained in the report of the Locomotive Testing Committee, now circulated to the Press by the Railway Executive. We publish a brief extract from this voluminous report elsewhere in this issue. The details so keenly awaited will be found to contain few surprises, and the apparent variations in the work of individual engines and crews suggest that if the trials had been continued over a longer period these variations might have been still further evened out. On the other hand, while the official report summarises the engine performance on each test run, the timings of outside observers show that there was often a wide disparity between the methods of individual enginemen in the make-up of the overall performance. The reports from unofficial sources now form a valuable background to the data published by the Railway Executive.

It would seem that no standardised code of driving practice was imposed upon the engine-men taking part, and each seems to have run according to his fancy, within the limits imposed by permanent way and other restrictions peculiar to the road, and imposed in some cases by the personality of the conductor driver of the "home" region. Some drivers were clearly out to save every ounce of coal they could, and did so by running uphill at less than scheduled speeds, and by endeavouring to regain their losses by utilising the high-speed capacity of their engines downhill. Others were perhaps more punctilious, while a third category included drivers who seemed to disregard booked times altogether and concentrated upon securing maximum power output from their engines even though this procedure involved them in signal checks and heavy coal consumption. It is true that the relating of coal consumption to the actual work done eliminates many of the variables introduced by such marked differences in driving practice, but even so it will be apparent from the extracts that we print on another page that there were fluctuations no less striking in the performance of individual engines as between one trip and another. Some idea of the absence of consistency in the running conditions from day to day will be gained from the variation in the coal consumed per train mile. As to the figures of coal per d.h.p. hour we have the most vivid recollection of test results given to us some twenty years ago by Sir Nigel Gresley, taken with one of his standard 180 lb "Pacific" engines, running on its own line, with its regular driver and fireman, when the coal per d.h.p. hour on six return trips from Doncaster to King's Cross, on successive days, varied between 2·89 lb and 3·44 lb. In the trials of 1948 the overall averages of the five express passenger classes included, taken over the complete set of tests, varied between 3·06 lb and 3·60 lb per d.h.p. hour.

The Western Region men had to accustom themselves to coal having properties very different from those with which they are familiar. The report makes a particular point of this, though in general these Western crews did well, particularly with the "King" class 4–6–0 on the Leeds-King's Cross runs, and with the 2–8–0 mineral engine. But the coal, although of a different grade, was of good quality. One of the major difficulties of to-day is not variation in grades but variation in quality, on some journeys even from hour to hour. On a fast run, of which we have a report, removal of a decorative top layer of hard coal revealed a less attractive assortment, in which briquettes kitchen nuts, and dust were the most prominent constituents. The modern locomotive is required to steam, and steam freely, on such fuel as this, and it will be one of the tasks of the future to adapt grate and smokebox arrangements to make it possible. Reverting to the exchanges, the Bulleid "West Country" "Pacifics" seem to have carried off some very substantial honours so far as maximum power output was concerned, and although the recorded coal consumption was heavy we can well imagine that the class will be most carefully studied on one or other of the stationary testing plants, where nowadays the final arbitrament on points of thermal efficiency will presumably, be made. Among other individual results it is pleasing to see Sir Nigel Gresley's famous "A4" streamlined "Pacifics" coming out so consistently well in coal consumption, though from the example quoted in our previous paragraph any such figures taken on road tests must be regarded with a certain reserve. But in our opinion the results as a whole form an outstanding tribute to the working efficiency of British locomotives in general, and among express engine designers the names of Collett and Stanier must be coupled equally with those of Gresley and Bulleid. The locomotive heritage of British Railways is a proud one. The accumulated knowledge and experience of such renowned locomotive building centres as Crewe, Doncaster, Eastleigh and Swindon is now being pooled, and we look forward with confidence to the emergence of new designs embodying not merely the best in past practice, or again the minimum of improvement necessary to keep merely abreast of exacting modern requirements; we look forward to recording touches of genius, touches as of a Churchward or of a Chapelon, that could lift British locomotive practice to a position of undisputed pre-eminence.

THE ANGLO-AMERICAN AERONAUTICAL CONFERENCE IN NEW YORK

WHEN the aeronautical conference of 1947 was planned by the American Institute of Aeronautical Sciences and our own Royal Aeronautical Society, it was decided to hold the first meeting in London, and to include in its agenda some of the novel problems which arise in design and manufacture through the gradual change in conditions under which flying services are operated, such as the increase in speed and the greater altitude of travel. The exchange of ideas on these and other matters proved so useful that the sponsoring bodies decided that there should be a second such conference this year, and to hold it in New York. This meeting has now concluded, and it is clear from preliminary reports of its proceedings that it proved no less a success than its predecessor. Nearly a hundred visitors from this side of the Atlantic are reported to have attended and about a dozen papers were contributed from each country; if the difficulty of getting these papers ready in time to be printed and circulated before discussion proved about as tough as it had done two years earlier, this

might perhaps be one of the lesser problems to be studied in future conferences.

Judging from experience of the first conference it will be some time before the volume containing the report of the discussions is published, but there is evidence from Press reports that many of the questions discussed were of first importance and that the sooner their implications, especially for civil flying, are realised the better. The agenda ranged, as was natural, from the basic problems of the supersonic flight of fixed wing aircraft to the complex stability conditions in multi-rotored helicopters; but of especial importance was the somewhat mysterious one of the "probability of life" of the modern form of airliner when subjected to long continued fatigue stresses. This particular question was raised by one of the British papers, that of Mr. H. A. Wills of Melbourne. Mr. Wills held the evidence to show that there had been an increasing number of failures in aircraft structures due to fatigue, and that if, fortunately, few had led to fatal accidents, they had been numerous enough to indicate that their recurrence must hereafter be regarded rather a "present probability" than a remote risk; he warned his hearers that past experience must be of limited value as an index to future trends because certain new design factors could hardly fail to increase the liability to fatigue failure. These were the steady and considerable increase in wing stresses, especially in relation to present-day load factors, and the equally steady rise in designed cruising speeds, both factors combining to increase, in any given time, the number and intensity of the impulsive loads. And to these might be added the increased chance of sudden encounters with the "clear weather" bump phenomena which appear to accompany flying at the greater altitudes. That heavy cumulus clouds do sometimes contain internal turbulences so violent as to be capable of breaking the structure of almost any aircraft that is rash enough to try conclusions with them is well known. Fortunately, however, clouds of this sort are commonly detectable by air-borne radar instruments whether by day or by night; but the reported existence in apparently clear air, at high altitudes, of patches of violent turbulence which cannot be foreseen visually or by instruments, is one more worry for those responsible for the comfort and safety of air travel, and as pointed out during the conference by Mr. Dykes, is likely to prove a "very considerable problem." Estimates of safety in any human enterprise have necessarily to be based on statistical experience to ensure that the pitcher shall not go once too oft to the well. This calls for a carefully planned scheme of continuous measurement, with the provision of appropriate recording instruments. For this purpose much use has been made in the past of recording accelerometers of one sort or another: but they suffer from the disadvantage that the corresponding strains have then to be calculated on some plausible theory (which may or may not be correct), and it is far better where possible to measure the strains themselves. A *prima facie* case was certainly made out for this at the conference.

In the Australian Aeronautical Division investigation into this matter, use was made of specially designed strain-counters. In this way it was found to be practicable not only to reduce the great amount of labour otherwise necessary for analysis, but to obtain a direct and accurate result by the automatic counting of the number of occasions on which the strain, at the point where the device was located, exceeded a set value. In view of the almost uncharted seas which lie ahead in the venturous future of civil aviation there would seem to be abundant reason for the speedy gathering of information such as this. Hence, this Australian preliminary work, and the fruit of the conference discussion thereon, can hardly fail of a cordial welcome. Among other important topics included at the conference was the ever-present problem of the relative merits of very large landplanes and large flying boats now under construction, especially in their relation to the alarmingly increased cost of providing and maintaining the appropriate airports; another was the much-debated question of what future lies before the new turbine-engined airliners, not only as regards their technical characteristics but in relation to the very practical question whether their greater freedom from mechanical vibration and attendant noise will prove so great a factor with the air-minded public as to be of almost decisive importance.

Literature

Principles and Practice of Radar. By H. E PENROSE. London: George Newnes, Ltd. Price 42s.

THIS work is based on radar as developed during the war and is planned to help those who are hoping to take part in the application of radar to peacetime uses. It starts from the level of knowledge of a really competent radio operator or amateur and builds up to that required by those installing or maintaining radar plant in any situation. It is a book for practical men rather than for theorists, for those who want to learn how to build and use rather than for those who want to do research.

One advantage of having this limited target is that simplification can be achieved by omitting difficulties, and that essential information can be conveyed without overloading with the sort of detail that is rarely wanted. It is very noticeable that no attempt is here made to apportion the credit among the hundreds of designers and inventors who have helped to create this great mass of new technique. The apportionment of credit can become one of the greatest of difficulties confronting an author, for if he starts on it a great deal of exploratory reading is involved. The author's firm avoidance of the discussion of priorities is one of the reasons why this book of less than 700 pages is so comprehensive and perspicuous.

In this matter of simplification the author is very successful. His businesslike style of writing is supported by the use of abundant diagrams. The diagrams are clear and simple, and reasoning by their aid often eliminates the need for mathematics. In the diagrams, as in the text, the author avoids superfluous detail—and is not precise where precision does not matter. Of course, on occasion, his excursions into physics are too hurried to be accurate, but pure science may be studied elsewhere. And where mathematical treatment is clearly desirable this is collected into useful appendices on the Theory of Transmission Lines, of Wave Guides and of Cavity Resonators.

Practically all branches of radar are dealt with. The basic principles of pulsing systems, the development of time-control pulses and of radar time-bases, the circuits for microwave frequencies, the details of the resonant magnetron, together with descriptions of display units, aerials and feeder systems are all adequately dealt with in turn, and a careful reading shows that there are not many mistakes or ambiguities. In the opinion of the reviewer the work deserves a place on any radio engineer's shelves.

SHORT NOTICES

The Properties of Soft Solders and Soldered Joints. By J. McKeown, D.Sc., M.I. Mech. E., F.I.M. London: The British Non-Ferrous Metals Research Association, Euston Street, N.W.1. Price 17s. 6d.—The British Non-Ferrous Metals Research Association has always taken an interest in the problems of solders and soldering. The results of its first investigations appeared in 1932 in the Association's Research Monograph No. 1, "Tin Solders," by S. J. Nightingale. The tin shortage following the beginning of the war in 1939 prompted the Association to undertake researches on solders of lower tin content. Information was lacking on the mechanical properties of the tin economy solders and joints made in them. To fill this gap a wide variety of tests were carried out over a series of temperatures, including tests on the creep properties of joints made with a range of solders. In addition, comparison was made (by soldering, area-of-spread and capillary penetration tests) of high-tin and tin-economy solders. The hot tearing of solders was examined in order to define suitable compositions for the avoidance of this trouble, and investigation was made of the soldering of aircraft oil coolers by lead-rich solders. All of this experimental work and the conclusions drawn from it are described by Dr. John McKeown, who led the team concerned with this wartime research.

The Development of North-East England

A PLAN for the future development of North-East England, which has been prepared by Sir George Pepler and Mr. P. W. Macfarlane, has been published this week. Its preparation was commissioned by the Minister of Town and Country Planning, but it is pointed out that the views expressed are those of the consultants themselves and do not at this stage represent Government policy. In considering the area, close attention has naturally been paid to the probable developments in the Northumberland and Durham coalfields, and the authors of the plan explain that "care for coal has caused them to modify some of their proposals drastically." But in districts where mining may, over a period of years, provide less employment than at present, the setting up of new industries is recommended "according to the circumstances of each case." Industrial expansion is suggested, for instance, at the Team Valley Trading Estate, Stanners, Newburn, Haugh, Langley Moor, Aycliffe, and, to a limited extent, on Tyneside. Industrial proposals apart from those directly concerned with coalfields, include one for a comprehensive redevelopment scheme for the south bank of the Tyne which, the plan recommends, should be implemented by a special authority created for the purpose. Other proposals relate to the introduction of new industries into Sunderland to lessen the domination of that town's economy by shipbuilding; the widening of the River Wear; and the provision of accommodation on Teesside for an additional 51,000 people to meet the demand for a greater labour force. Proposals concerning transport include the building of a new regional airport at Boldon, the construction of a railway tunnel under the Tees at Middlesbrough, the reconstruction on two levels of Newcastle Central Station, and various electrification schemes for the South

Tyne and Newcastle-Carlisle railway lines. The principal road proposal outlined in the plan is for the construction of a new motor road, roughly bisecting the North-East England area from north to south, between the coast and the Great North Road, via the new Jarrow Tunnel, with links to Newcastle, the regional airport, South Shields, Sunderland, the Hartlepools, Teesside, Darlington, and Aycliffe.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THE "TIRPITZ"

SIR,—

On July eight, page thirty-nine,
The "Tirpitz" figures in a line;
Am I right, or do I dream,
Nearly a quarter mile of beam;
The length as well—now please don't smile—
By over a half exceeds the mile.

G. A. PICKETT

Bedford, July 8th.

[The addition of a nought to the length and beam of the "Tirpitz" was the result of a printer's error.—ED. THE E.]

THE DOVER-OSTEND MOTORSHIP "CAR FERRY"

SIR,—My attention has been drawn to your article "The Dover-Ostend Motorship 'Car Ferry,'" dealing with this vessel's recent introduction to the cross-channel services, which I have read with interest.

It is noted that reference is made to the provision of car-loading ramp facilities at Ostend and that it is hoped similar arrangements for loading and discharging of cars will be provided at Dover.

In this connection you will be interested to learn that the Dover Harbour Board, in consultation with the various authorities, operating companies concerned and road touring clubs, have for some time been considering the future requirements of cross-channel car traffic in relation to port facilities.

The proposals which are now reaching finality comprise the provision of two special loading or discharging berths, with bridge connections between shore and ships. Immediately adjacent to the berths, provision is to be made for a large car ferry terminal or transit shed of sufficient size to handle, under cover, not less than 240 cars in an hour. The building will, of course, provide adequate office accommodation, &c., for the various Government departments, operating companies and touring clubs, with a buffet and cloak rooms for passengers. Large car parks are also to be provided for the reception of cars inwards or outwards.

It is anticipated that it may be possible to commence the works in 1950 with the object of handling all the motor-car carrying vessels (excepting the train ferries) employed on the short cross-channel routes, viz., Dover and Calais, Boulogne, Ostend.

CECIL BYFORD
General Manager,
Dover Harbour Board

Dover, July 8th.

CAPE TOWN'S NEW STATION.—According to *The South African Engineer*, work is likely to be started before the end of the year on the construction of the eighteen-storey administrative block planned for the new railway station at Cape Town. This building, it is stated, is only one of the items in a £14,000,000 plan for improving transport facilities in Cape Town. Four other schemes now proceeding are the construction of a new marshalling yard and station at Bellville, a carriage yard for main line stock near Duncan Dock, electric running sheds at Salt River, and a goods yard on the foreshore.

The Royal Show at Shrewsbury

No. II—*Continued from page 46, July 8th*)

THE Royal Agricultural Society's Show, which ended at Shrewsbury on Friday last was, from the point of view of the exhibits, the largest to be staged in the 110 years of the Society's existence. The attendance during the four days totalled 186,678, which was considerably lower than the record attendances at the other two shows held since the war at York and Lincoln. There was a large company present on Wednesday of last week, when H.R.H. The Princess Elizabeth, Duchess of Edinburgh, this year's President of the Society, and H.R.H. the Duke of Edinburgh, visited the show and spent several hours in its various sections.

As usual, the machinery stands attracted the attention of numerous visitors—both from home and overseas—during the four days of the show. It was evident that most of these visits were by no means in the nature of casual sight-seeing. They demonstrated once more that farmers, farmworkers and implement dealers are anxious to be as fully informed as possible about the advances that are made from year to year in the equipment designed by engineers for the agricultural industry.

Reference was made in our last issue to the Royal Agricultural Society's Silver Medal Competition for new implements, for which the judges were Dr. Cornelius Davies and Mr. E. R. Jackson. There were twenty-eight entries accepted for adjudication and medals were awarded as follows: Cooper Stewart Engineering Company, Ltd., electric cattle de-horner; Harry Ferguson, Ltd., one-man manure loader and spreader combination; Mr. Eddie T. Y. Gray, "Tip-it-al" trailer; Harvest Saver and Implement Company, Ltd., portable pylons for electric fencing; Marconi Instruments, Ltd., electric moisture-in-grain meter; Pest Control, Ltd., "Spraycopter" helicopter; Rotary Hoes, Ltd., Howard "Bantam" rotary hoe; John Salmon Engineering Company, Ltd., sugar beet harvester; and Weldall and Assembly, Ltd., lime and fertiliser spreader.

In what follows we continue our descriptions of some of the more novel implements and machines displayed at the show.

J. CHRISTOPHER AND SONS, LTD.

The Dollé automatic potato planter was invented by a French agricultural engineer, and is now being manufactured under licence in this country by J. Christopher & Sons, Ltd., 172, St. John Street, London, E.C.1. It was among the entries accepted by the R.A.S.E. for this year's Silver Medal Competition. The planter, which is illustrated in Fig. 7, incorporates a mechanism which picks the potatoes out of the hopper by a series of cups, with spring-loaded claws, mounted on a narrow revolving drum, driven from the land wheel. The stem of each claw has two protruding fingers which work in conjunction with a semi-circular cam covering the lower half of the cup's travel. This cam engages with the fingers to open the claw and enable the potatoes to drop on the back of the preceding cup as it passes into a guide. The potatoes are thence dropped into a vertical chute through which they fall into the furrow prepared by the share at the front end of the planter. At the rear of the machine, ridging units are provided which close the furrow and cover the seed with the required depth of soil. A feature of the Dollé planter is an ingenious correcting device which comes into operation if a cup fails to collect a potato from the hopper. This device consists of an endless chain on which twelve potatoes are placed;

FIG. 7—POTATO PLANTER—CHRISTOPHER

if a cup in its traverse through the hopper, fails to pick up a potato, one of the claw fingers strikes a star wheel which turns the endless chain sufficiently to deposit one potato in the guide and thus prevent a miss in the planting sequence.

A. M. RUSSELL, LTD.

The setting out of cabbage and similar plants by hand is a task which can seldom be performed speedily or economically, even by experienced workmen. The "Multiplanter," manufactured by A. M. Russell, Ltd., 213-221, Balgreen Road, Gorgie, Edinburgh, is one of the machines which have been devised to improve upon the orthodox method

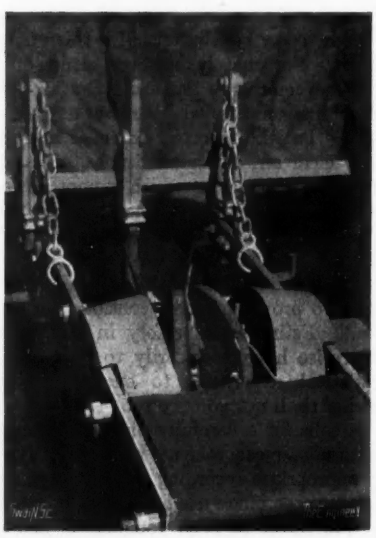


FIG. 8—"MULTIPLANTER" FEED ATTACHMENT—RUSSELL

of hand-planting. The implement is available for attachment to the rear toolbar of a tractor, but the firm also produces a complete trailer model, with hand lift, an illustration of which is given in the engraving, Fig. 9. This particular version of the "Multiplanter" deals with two rows at a time. It comprises two identical units, each consisting of a knife coulter to clear away

rubbish and loosen the soil, a trench opener, two press wheels, and seats for two operators. One operator hands out the plants from a box placed on the main frame, while the other, who occupies the canvas seat behind the press wheels, feeds them into the trench. Each of the units is attached to the main toolbar frame by the use of the four existing tine clamps, one each for the coulter and trench

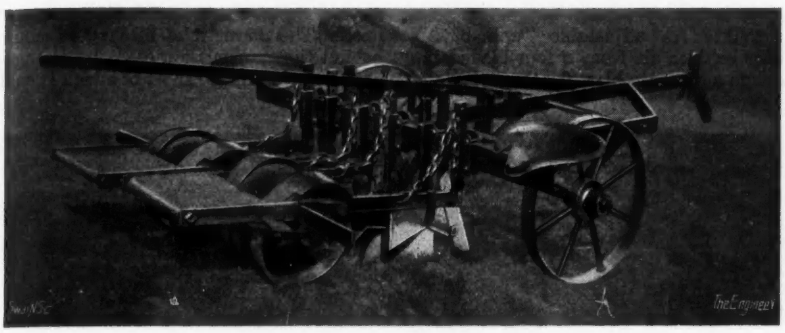


FIG. 9—"MULTIPLANTER" CABBAGE PLANTER—RUSSELL

opener and two for the frame carrying the press wheels. This latter frame is hinged, and incorporates a pair of chains to lift the press wheels when turning. As may be seen in the illustration, the press wheels, which are set at an angle of 12 deg. from vertical, are mounted in front of the planter's seat and follow directly behind the trench opener. To facilitate even spacing of plants, in the rows, a clicking gear is provided. The operator who occupies the canvas seat inserts one plant into the trench at each "click" of the gear, and the wheels then press the earth firmly around its root.

Recently, however, the actual planting operation has been mechanised a stage further by the introduction of a "Ritchie" easy-feed attachment. This device, illustrated in Fig. 8, consists of two revolving rubber discs mounted vertically between the press wheels. The discs lie flat against each other at the front, but are kept apart at the rear by small rollers, which enable the plants to be placed root-upwards between the tops of the discs just before they meet. As the discs move apart, the plants are deposited in the ground.

Byron Farm Machinery, Ltd.

A tractor, designed primarily for row crop work, was one of the principal exhibits of Byron Farm Machinery, Ltd., Blackhorse Lane, Walthamstow, E.17. It is known as the Byron Mark II, and is particularly well-suited to many tasks for which the use of a heavier tractor would be uneconomical.

As will be seen from the engraving, Fig. 10, the Byron Mark II is a three-wheeled tractor, an arrangement which simplifies wheel adjustment for dealing with various row-widths. An independent brake is provided for each of the rear wheels, to provide a small turning circle; at the end of a row one wheel is locked for turning, and the tractor swings round on it. When required, however, the brakes can be operated simultaneously. The tractor is driven by a Ford industrial 10 h.p. pressurised water-cooled petrol engine, with a gravity feed fuel system, and controlled by a finger-tip Bowden wire-operated throttle. A one-piece bonnet enables easy inspection of the engine to be made, while the accumulator is situated in an accessible position on the footplate. The wheels are of cast iron, in one piece, and are fitted with pneumatic tyres, but for operating in narrow rows steel spudded wheels with 4½in treads are provided. The design of the cowling and wings is such as to give the driver clear vision in all directions. As indicated by the engraving, the 7ft toolbar on the Byron Mark II is centrally placed. It is equipped with nine "stalks" for mounting tool points and with adjustable depth wheels, markers being also provided to ensure exact spacing of work between the rows. A supplementary rear toolbar is fitted with three track eliminator points to remove wheel marks. The toolbars are manually-operated by a lifting lever, which is placed conveniently near the driver's seat. The makers claim that in top gear the tractor has drawbar pull of 900 lb, in second, a pull of 1200 lb, and in first gear a pull of 1500 lb.

Another exhibit of special interest on the Byron stand was a pneumatic grain conveyor, with a vertical lift of 20ft. Its output is said to be over 2 tons per hour, the driving power required being 4 h.p.

David Brown Tractors, Ltd.

Two new tractors were among the many items displayed at Shrewsbury by David Brown Tractors, Ltd., Meltham, near Huddersfield. They are a diesel-engined "Cropmaster" and a crawler tractor known as the "Trackmaster." The first of these machines is similar in most respects to the firm's standard "Cropmaster" tractor, but it is powered by a four-cylinder, high-speed, high-compression, direct ignition engine, developing 25 b.h.p. at its governed speed of 1400 r.p.m. This engine has been designed

FIG. 12—"TRACKMASTER" TRACTOR—DAVID BROWN

and is being produced by David Brown Tractors, Ltd. The second tractor, the "Trackmaster," shown in Fig. 12, is fitted with an engine which is basically similar to those provided for the firm's standard tractors. The cylinder bore has, however, been increased from 3½in to 3⅝in, and the governed speed from 1300 to 1600 r.p.m., giving 30 b.p.h. instead of 25 b.h.p. Alternative track widths, of 40in, 48in, 56in and 64in are available, the 40in and 48in and the 56in and 64in models being inter-convertible. The "Trackmaster" is equipped with power-controlled steering by a system of epicyclic gearing used in conjuction with a spur differential. When turning, one brake is locked and the speed on that side reduced, whilst the speed of the other track is increased in direct proportion. Both tracks continue

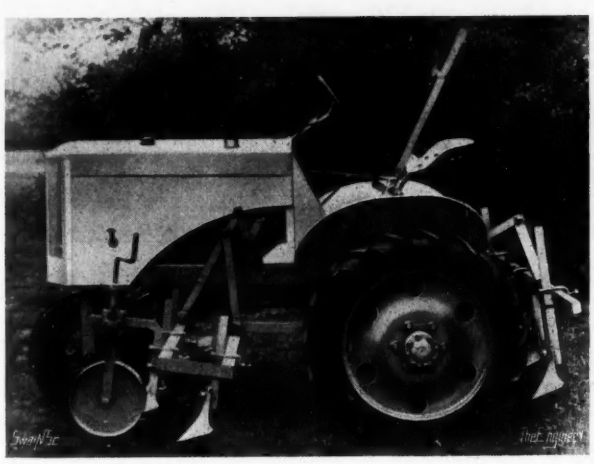


FIG. 10—MARK II TRACTOR—BYRON

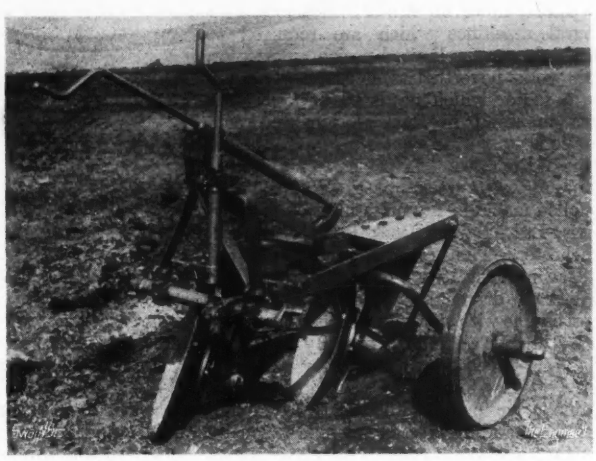


FIG. 11—DISC PLOUGH—DAVID BROWN

in motion and the tractor moves round in a definite curve. Thus, with the 40in track model, the makers claim a turning radius of 7·6ft.

The firm was also showing the full range of implements designed for use with the various types of David Brown tractor. One of these is the power-controlled disc plough, illustrated in Fig. 11. In the construction of this implement special attention has been paid to the requirements of overseas users, as in areas where the soil is sunbaked, or where there is an excessive top growth, it has been found that disc ploughs are distinctly advantageous. This twin-disc plough is power-controlled and can be attached to the three-hitch points of the "Cropmaster" tractor in the same way as the standard mould-board plough. The steel discs are each of 26in diameter, and are mounted in taper roller bearings in a fabricated support to a triangular steel frame. A rigid by bolted under the rear bearing housing takes the side thrust when the implement is in use. Depth of working is controlled by a depth wheel similar to that fitted to the firm's standard mould-board ploughs, and a lateral control is provided to adjust the forward angle of attack of the discs.

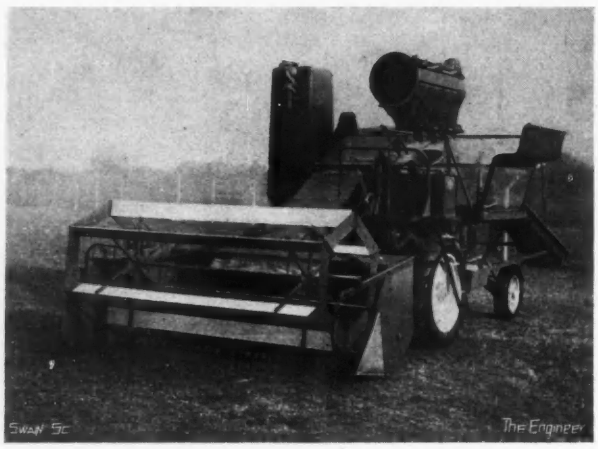


FIG. 13—SELF-PROPELLED COMBINE HARVESTER—MASSEY-HARRIS

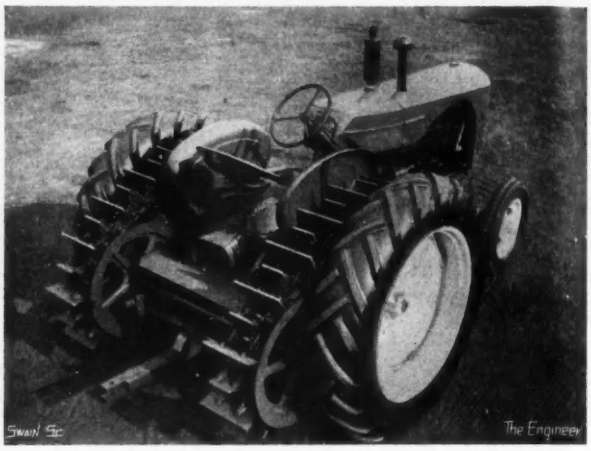


FIG. 14.—DIESEL-ENGINED TRACTOR—MASSEY-HARRIS

MASSEY-HARRIS, LTD.

The number of combine harvesters used in this country has increased rapidly since the war, and recent improvements in their design have shown that, despite the uncertainty of the British climate, these machines can be employed very effectively for the reaping and threshing of most corn crops. Combine harvesters, however, are among those agricultural machines which are required to operate for a very limited period every year. Their work, nevertheless, is extremely arduous, a factor which needs to be kept very much in mind in their design and construction.

One of the latest "combines" exhibited at Shrewsbury last week was the No. 726 self-propelled machine, manufactured by Massey-Harris, Ltd., Barton Dock Road, Stretford, Manchester. The machine, which has a cut of 8½ft, is illustrated by the engraving Fig. 13. It is driven by a 56 b.h.p. Austin petrol engine with six cylinders, having a bore of $3\frac{7}{16}$in by $4\frac{3}{8}$in stroke. By a clutch pedal and lever-controlled pulley and belt device, twenty-four speed variations can be obtained, ranging from about 1 to 7½ m.p.h.

As the standing crop is cut it is taken by a battery-operated auger to a large-capacity floating elevator, which delivers it through a stripper-beater to the threshing drum. The drum is an eight-bar rub type, with an adjustable concave, and speed variations are effected by a sprocket change. Its maximum speed is 1200 r.p.m. From the drum the threshed straw is handled by four double-crank action straw "walkers" and is thence ejected at the rear of the machine. At the same time, the grain is cleaned by an upper and a lower sieve and is carried by worm from beneath the lower sieve to a chain and bucket elevator, which delivers it either to a rotary screen bagger or to a grain tank. An adjustable "split-blast" deflector enables air from a four-bladed fan to provide a separate blast for the upper and lower cleaning sieves, the surface area of which are 907 square inches.

The complete machine, which weighs approximately 6800 lb, is carried on four pneumatic-tyred wheels, running on tapered roller bearings, the two front wheels taking the traction drive and the rear wheels the steerage. Roller chain and vee belt drives are provided throughout the No. 726 combine harvester, and safety clutches have been incorporated at all particularly vital points.

In the engraving Fig. 14 we illustrate the "744 P.D." tractor, production of which has recently been begun by Massey-Harris, Ltd. The standard and rowcrop models of this new tractor are fitted with a Perkins six-cylinder diesel engine, the cylinders, which are of 3½in bore by 5in stroke, having removable dry steel liners. At 1350 r.p.m. the engine has an output of 42 h.p. and the transmission, which is of the selective sliding gear type, is provided with five forward speeds ranging, in the standard model, from 2·19 to 12 m.p.h. The main tractor frame, in which the engine is mounted, carries the steering wheels at the front and is bolted to the transmission case at the rear. The makers claim that this construction adds to the strength of the tractor and ensures that no stresses are transmitted to the engine itself. The power take-off shaft is mounted behind the transmission case and is engaged by a dog clutch, the shaft of which is splined with S.A.E. $1\frac{3}{8}$in diameter standard splines rotating at 534 r.p.m. at full governed engine speed. A belt pulley, 13½in diameter with a 6in face, is fitted on the offside of the tractor. It is operated by the power take-off dog clutch control, through spiral bevel gears, and runs clockwise at 863 r.p.m. at full governed engine speed, giving a belt speed of 3050ft per minute. In addition, a quick-acting lift, actuated by the power take-off shaft, can be fitted to the tractor, while another feature—as the illustration indicates—is that half-track equipment can be provided.

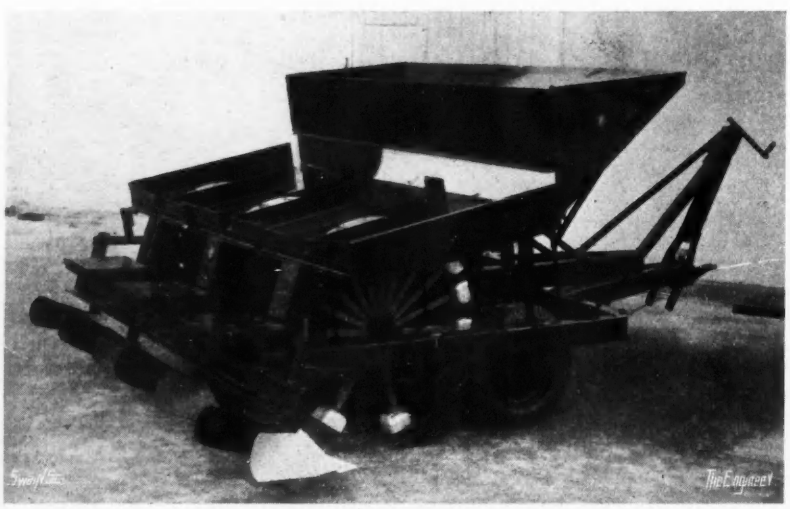


FIG. 15—PACKMAN POTATO PLANTER—MODERN DESIGNS

MODERN DESIGNS, LTD.

At last year's Royal Show, Modern Designs, Ltd., Twyford, Berks, was awarded

a Silver Medal for the Packman potato harvester, a description of which was printed in THE ENGINEER of July 9, 1948. This year, the firm included among its exhibits a three-row potato planter which has been designed by Mr. P. J. Packman, and a photograph of which we reproduce in Fig. 15.

A distinctive feature of this machine is that it places the potatoes on to the soil, instead of dropping them. Potatoes, which are carried in a 6 cwt storage hopper mounted on the planter, are fed by an operator into receiving cups arranged on a rotor assembly. Each rotor assembly is belt-driven from a pneumatic tyred wheel running on roller bearings, and the whole unit is mounted in a frame. There are thus three frames, the centre one being permanently fixed to the cross members of the machine, and the two outer frames being adjustable to provide for row pitches of from 26in to 30in. The belt drive from the main wheel to the rotor runs on a triple vee-pulley at the wheel end and a double vee-pulley at the rotor end, and by a simple change-over of these pulleys the planting pitches of the potatoes can be varied between 7½in and 18in. The drawbar height is adjustable between 10in and 17in from the ground to suit different tractors, and by means of a screw type lift gear the back end of the planter can be raised clear of the ground when turning at the headland. Finally, four double covering ploughs are fitted to the rear cross member of the machine, those on the outside being capable of independent lifting.

KENT ENGINEERING AND FOUNDRY, LTD.

A tractor-hauled sprayer for use in orchards was a prominent item on the stand of Kent Engineering and Foundry, Ltd., Tovil, Maidstone. It is known as the "Autoblast," its principle being to create the equivalent of a 100 m.p.h. gale, into which blast of air an insecticide is introduced by a bank of nozzles fitted at the rear end of the machine. Some idea of the size of this spraying unit is conveyed by the photograph reproduced in Fig. 16. Its main dimensions are:—Length, 14ft; width, 6ft 6in; height, 5ft. When empty, the "Autoblast" weighs 1½ tons, the weight when loaded being 3¾ tons.

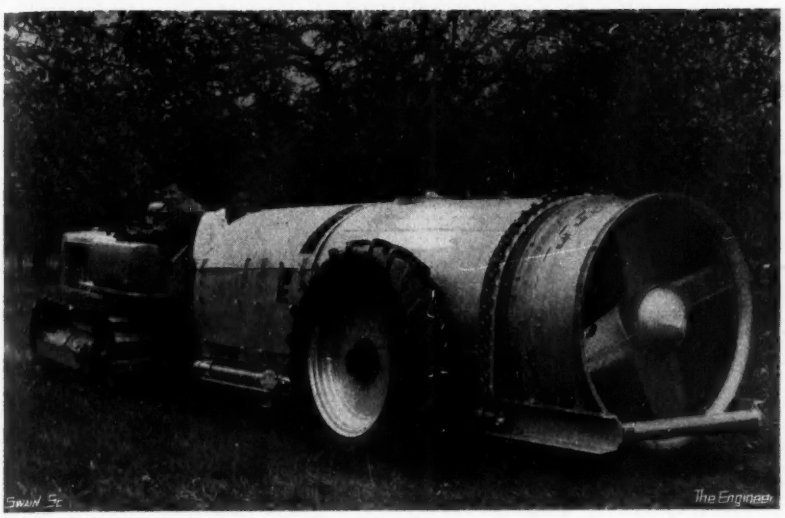


FIG. 16—"AUTOBLAST" SPRAYER—KENT ENGINEERING

The machine, which is mounted on two large pneumatic-tyred wheels having roller bearing hubs, is fitted with a Ford "V8" engine, capable of driving the air flow propeller and water pump. The engine is placed at the front end of the machine. The axial-flow propeller, which has been specially designed for the "Autoblast" sprayer, is situated at the rear end of the machine and, drawing a supply of air from the rear, forces it forward through air flow vanes which change the direction of the air with the minimum loss and deliver it in a flat semi-circular fan-shaped "wall" at right angles to the machine. A low-pressure self-priming pump is claimed to be capable of delivering 100 gallons of wash a minute to the bank of nozzles which is situated adjacent to the air stream. The nozzles are arranged in sections, each section having its own control from the operator's platform. In addition, each nozzle is fitted with a valve and can be controlled individually. The spray tank is of 450 gallons' capacity and is fitted with an input valve, manhole and strainer. As it is mounted over the axle, between the engine and the air outlet vanes, the balance of the machine is maintained whether the tank is empty or full.

A point of interest in this spraying machine is that the water pressure is low, just sufficient, in fact, to atomise the insecticide, and in dealing with orchards the air blast carries the globules of wash into the trees as the machine passes them. The air in the trees is forced out by the blast from the machine and is replaced by air highly charged with insecticide. The size of the globules of insecticide can be adjusted by regulating the fineness of the spray from the nozzles. When operating the machine, however, it is essential to have an adequate water supply conveniently near, in view of the high output of 100 gallons of spray a minute.

(To be continued)

Fluorescent Lighting at the I.E.E.

AN extensive installation of fluorescent lighting using Osram lamps and G.E.C. fittings has recently been completed at the Institution of Electrical Engineers, Savoy Place, London, W.C.2. In several instances decorative fittings, designed for the previous tungsten filament lamps have been retained, and considerable savings in power consumption have been effected by the use of fluorescent lamps. In the lecture theatre, for example, the new cold-cathode lighting, which takes some 10kW, replaces a 21·5-kW tungsten filament installa-

LIBRARY

CANTEEN KITCHEN

tion, and provides an increase of 30 per cent in the general illumination.

A glazed pendant fitting of special design, containing twenty 2-ft, 20-W lamps, lights the main entrance hall, as illustrated below. Inside this glazed fitting the lamps are arranged horizontally along the four sides and the bottom of a central box which contains the associated equipment. With this arrangement the upper lamps throw light on to the ceiling, illuminating its decorative features and helping the visitor to appreciate the height and spaciousness of the hall. The eye is directed also to the presidents' name panels in the background, illuminated by two two-lamp "Perspex" enclosed fittings mounted on their sides, opposite the panels, in positions concealed from the main area of the hall. The illumination in the hall is about 7 lumens per square foot, measured at about 3ft above floor level.

The lecture theatre, opening out of the entrance hall, is lit entirely by cold-cathode tubing. The second illustration on this page gives a view of the lecture theatre, showing the four dropped laylights (made by the G.E.C. many year ago). Each laylight now contains 158ft of "warm-white" tubing in grid formation. In addition, the theatre has indirect lighting from a double run of tubing round the cornice, which helps to illuminate the lower curve of the decorated ceiling. Each part of the theatre lighting is controlled by a motor-driven dimmer installed in the basement and operated by push buttons. During the showing of slides or films, a low level of illumination can be obtained from the cornice lighting, used by itself, in a partially dimmed condition. The average illumination provided in the theatre in the full-light condition is about 6 lumens per square foot. A higher level was considered undesirable because it would have resulted in excessive brightness contrast due to the dark colour of the panelling and furnishings.

Hot-cathode fluorescent lamps provided the whole of the lighting for the library, which is illustrated on the previous page. The bookshelves on the windowless side (right) and at the ends of the room are lit by forty-eight 2-ft, 20-W lamps mounted under the gallery. These lamps are the longest which could be fitted in semi-concealed positions between the main joists supporting the gallery. The illumination on the shelves averages 14 lumens per square foot. The five pendant fittings down the centre of the room, which previously contained tungsten filament lamps, have been reglazed with white flashed opal glass and equipped with six 5-ft fluorescent lamps each. A standard 5-ft channel fitting with glazed sides has been used over each of the six readers' alcoves on the side of the room opposite to the main shelves and overlooking the Embankment.

In the Council Chamber, it was desired to retain the existing pendant fittings and at the same time to provide more illumination without increasing the loading. This has been done by replacing two of the six 150-W filament lamps in each fitting with 125-W high-pressure mercury vapour lamps. The single 100-W tungsten filament lamp, giving direct downward light in each fitting, has been equipped with a silvered glass reflector to improve the downward candle power. The result is that there has been a slight economy in the total power used, yet the illumination on the table is increased some five-fold and the general illumination in the room is much improved. The preponderance of incandescent light is such that colour distortion due to the mercury light is negligible.

The canteen and kitchen of the Institution have also been provided with fluorescent lighting. Six special "Perspex" enclosed ceiling fittings, each containing three 2-ft, 20-W lamps, give the main illumination in the canteen, supplemented by a 4-ft, 40-W lamp concealed behind the pelmet in each of the four windows. An alcove has its own indirect lighting from two 5-ft, 80-W lamps concealed within a plastic feature on the wall and decorated with a sea-shell design. Specially-designed table lamps, fed from floor plugs, have been provided for use on suitable occasions in place of the ceiling lights.

Cream-coloured tiles add to the impression of adequate light in every quarter of the kitchen. The illumination level here averages 12 lumens per square foot and the principal lighting comes from seven 5-ft vapour-proof fittings with white opal "Perspex" reflectors as illustrated on the previous page. Single-lamp channel fittings are provided in preparation rooms, &c., adjoining the kitchen.

Warm-white lamps are used for fluorescent lighting throughout the building, including the offices, a warm light being desirable so as to harmonise with the subdued colour schemes and the preponderance of dark panelling.

MAIN ENTRANCE HALL

COLD CATHODE LIGHTING IN LECTURE THEATRE

The Fell Diesel Locomotive

THE Railway Executive has issued brief preliminary details of a new type of main line diesel locomotive which is, at present, under construction at the L.M.R. works, Derby. This new engine is being constructed to the designs of Mr. H. G. Ivatt, the chief mechanical engineer of the London Midland Region, in collaboration with Fell Developments, Ltd., and Ricardo and Co., Ltd., and is known as the "Fell" locomotive. In this locomotive, the power is transmitted mechanically to the driving wheels, and the system of transmission and other ancilliary features have been developed by Lieut.-Col. L. F. R. Fell.

The new locomotive has a 4–8–4 wheel arrangement and a driving cab at each end. Four supercharged diesel engines, each developing 500 h.p., are housed in pairs at each end of the locomotive, and are coupled to the driving wheels through fluid couplings and a gearbox in such a manner that the main engine horsepower is maintained as nearly constant as possible over the designed range of engine speeds, and the necessary high torque on starting and at low speeds is obtained without any form of torque multiplier. Auxiliary diesel engines are used to drive the blowers for the main engines and auxiliaries such as fans, water and oil pumps and services for starting and lighting.

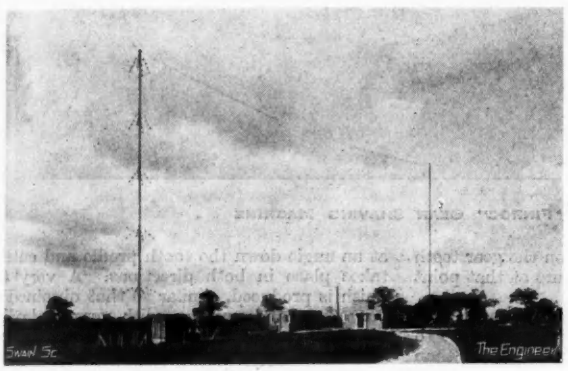
The gearbox unit, which combines the drives of the four engines, is placed amidships, and the drive to the wheels from the gearbox is through two transverse shafts which are coupled to the two inner driving axles by flexible quill drives. This drive allows for the rise and fall of the axleboxes in the horn guides and introduces an element of flexibility to protect the gearbox from traction shocks.

It is stated that owing to the low weight of the transmission equipment, it is possible in this locomotive to use engines of much greater piston area than in any existing diesel locomotives of the same weight for a given tractive effort. Lighter weight and lower transmission losses are said to be further advantages of this locomotive, which can be readily adapted either for high-speed passenger or heavy goods trains.

B.B.C. Transmitting Station at Postwick Grange

LISTENERS in Norwich and district should be enjoying improved reception of the B.B.C. Midland Programme from the new transmitting station which was opened at Postwick Grange on Sunday June 19th. The wavelength and carrier frequency remain unchanged at 296m and 1013 kc/s, but the transmitter power has been raised to 5kW, a considerable increase over that of the old station which was installed in Caley's chocolate factory early in 1941. In addition, the new station has a much more efficient aerial system. These two factors will give listeners in Norwich and the district a stronger signal, and will also bring Yarmouth within the service area.

The site at Postwick Grange covers about eight acres, fronting the Yarmouth road. On it have been erected two insulated mast radiators, the main transmitter building, and another building which is the garage and store. The main building is a single-storey brick structure approximately 60ft long and 25ft wide. The greater part of it is taken up by the transmitter hall, which measures 40ft by 20ft, the remaining space being divided between the workshop and storeroom, which leads off the transmitter hall, and the office of the Engineer-in-Charge and the kitchen, which flank the entrance hall. The office has been so constructed and equipped that it can serve also as a studio for a local broadcast or in an emergency, for which purpose it has been given a simple form of acoustic treatment. The equipment includes a ribbon microphone, connected to the programme-input equipment in the transmitter hall, and one of the special tables that are used in the B.B.C.'s studios.



POSTWICK GRANGE TRANSMITTING STATION

The transmitter employs the high-efficiency class "B" system of modulation and consists of four units arranged in line, backed by an enclosure containing the power and modulation transformers. Two interesting points in the design are the heavy negative feedback that is applied over the audio-frequency stages, and the remotely controlled motor-driven tuning controls for the final and penultimate radio-frequency amplifiers. The former ensures a good frequency response and low distortion, and the latter enables the components to be placed in the most convenient position from a circuit standpoint.

The four R.C.A. units which make up the transmitter present a uniform appearance, each having a flush metal front, with a glass panel let in, and a row of meters at the top. The left hand unit contains the final radio-frequency amplifier, consisting of two air-cooled valves connected in parallel. The modulation is applied to the anodes of these valves, and their output is coupled to the transmission line that runs out to the aerial.

In the second unit are the low-power radio-frequency and audio-frequency amplifiers. The output from the crystal-controlled drive, which is separate from the transmitter, goes through two stages of amplification in this unit, before being applied to the grids of the valves in the final radio-frequency amplifier. Similarly, the output from the programme-input equipment is amplified in three stages here and then taken to the modulator.

The third unit houses the modulator, which consists of two air-cooled valves operating in class "B" push-pull, with their anodes connected through the primary of the modulation transformer to the h.t. supply. Also in this unit are the six hot-cathode mercury-vapour rectifiers, fed from a transformer in the enclosure at the back of the transmitter, to supply the h.t. power at 9000V for the modulator and final radio-frequency amplifiers.

The supplies to the various circuits in the transmitter are controlled by push-buttons mounted on the front of the extreme right-hand unit. Within this unit are the push-button operated contactors and the interlock and protective circuits which ensure that no damage will result to the transmitter if the supplies are inadvertently switched on in the wrong sequence, or if there is an overload or a component failure. These circuits also protect the transmitter in the event of the feeder or aerial becoming earthed or being struck by lightning.

On the left-hand side of the transmitter hall is the programme-input equipment, where the incoming programme is amplified before being fed into the transmitter. In addition, there is monitoring equipment for checking the quality of the programme, and test equipment for measuring the performance of the transmitter.

The station is linked with the Midland Regional headquarters in Birmingham by two G.P.O. telephone lines, of which one carries the programme signals, and the other is used for telephone communication. The programme line is specially treated so that speech and music can be sent over it without loss of fidelity.

Alongside the programme-input equipment are two crystal-controlled oscillators, one for service and one for standby, which generate the carrier frequency for the transmitter. The components upon which the accuracy of the generated frequency depends are enclosed in a temperature-controlled oven to prevent frequency drift caused by changes in ambient temperature. These oscillators keep the frequency, and therefore the wavelength of the transmission at the correct value to within one part in ten million, which corresponds to an error of three seconds in a year. As a check, the frequency is compared daily with the B.B.C.'s frequency standard, which is constant to within two parts in a hundred million.

Two 126-ft tubular steel masts form the aerial system, which is directional. The masts are spaced 240ft apart, which corresponds to one quarter of the wavelength at the operating frequency of 1013 kc/s. The base of each mast is insulated from the ground and is connected to tuning circuits in its aerial tuning house, which is close by. The easterly mast is energised, the power being conveyed to it over a six-wire feeder from the transmitter. The westerly mast is not energised, but acts as a parasitic reflector and gives the aerial its directional characteristic, the circuits at its base being so tuned that the range of the station is increased towards the east. The stays supporting the masts are broken up into short lengths by insulators, to prevent large currents being induced into them. Between the mast-heads are stretched two parallel wires, the end sections of which act as capacitance tops, increasing slightly the electrical lengths of the masts.

Both the aerial tuning houses are thoroughly screened outside as well as inside, to prevent stray radiation and losses of radio-frequency power. The damp-proof courses are made of copper, and from them radiate networks of wires buried nine inches below the ground, forming the earth system.

The station draws its power from the Eastern Electricity Board's 6·6-kV 3-phase supply main. This supply is brought into a small sub-station, where it is transformed down to 415V and distributed around the station where the total connected load is about 50kW.

The "Finroc" Gear Shaving Process

THE demand for toothed gears capable of transmitting the high power and high rotational speeds of modern prime movers has in recent years stimulated much experiment and research with the object of improving the accuracy of pitch, contour and surface finish of the gears employed, to reduce the causes of noise and undue wear, whilst at the same time, improving the load carrying capacity, particularly in the case of turbine reduction gears.

To provide that final degree of accuracy, some post-hobbing process is required, and for this purpose a new gear shaving process has been developed by the Power Plant Company, Ltd., of West Drayton, Middlesex.

The "Finroc" system of gear shaving, as it is known, is claimed to be the only process which succeeds completely in removing those undulations which are inevitably formed on the teeth of helical gears cut on the hobbing machine, and which constitute a serious obstacle to the attainment of higher tooth loading and quiet running. The claim is also made that the special technique developed in the system results in a greater degree of correction as regards errors in profile, pitch, helix angle and surface finish, than is attainable by other methods.

The new gear shaving machine is made in a number of sizes for gear wheels up to 220in diameter, with face widths of 28in, on spur and single helical gears, or 56in on double helical gears. One of the photographs we reproduce shows a 60in machine and the other a close-up view of a pair of cutters in operation on a double helical gear.

It will be seen that the cutter consists essentially of a helical pinion, ground to the highest practicable degree of accuracy, with a helix angle equal to that of the gear to be shaved but of opposite hand. The cutter is provided with finely pitched radial slots on both flanks, and the edges of these slots form the cutting edges. When such a cutter is rotated in pressure mesh with a gear if there is also a relative sliding along the surface of the teeth, a cutting action takes place by virtue of the elastic compression of the gear material, although the cutting edges have no clearance. On the machine the cutter and gear are mounted on parallel axes, the gear driving the cutter, which is arranged to reciprocate in an axial direction. From this combination of rotation and reciprocation a satisfactory cutting action is obtained which results in the removal of a very fine chip in an angular direction. Since cutting takes place in both directions, a fine criss-cross pattern of cuts is produced on the tooth not

unlike that on a gear ground by a generating process. Means are provided to ensure equal cutting action at all parts of the tooth.

The "Finroc" shaving machine is of simple construction and is easy to set up and operate. On it, the gears are mounted on their own journals in bearings on adjustable pedestals and are driven from the headstock through a universal coupling. A complete range of speeds is available to accommodate different diameters of gears. For small gears with straight or single helical teeth, machines with single cutter heads are provided, and for double helical gears two cutter heads are provided on the machine so that this type of gear can be finished in one operation. The cutter heads are mounted independently on a slide which reciprocates with an adjustable stroke in a direction parallel to the gear axis. This reciprocating motion is imparted to the slides through a crank mechanism and an infinitely variable range of speeds is available.

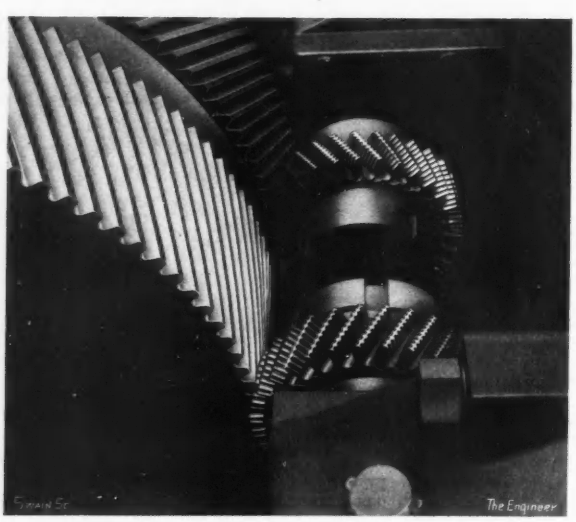
The cutter head slide is carried in a massive saddle which is adjustable at right angles to the gear axis to suit different diameters, and is used for rough setting purposes. The cutter spindles are carried in blocks in the cutter heads, which can be advanced towards the gear in very fine increments, either independently or in unison. On top of the saddle is a special compound setting slide, from which a dial gauge can be supported for purposes of checking the gear journals in two planes. This setting slide is designed to operate exactly parallel to the motion of the cutter slide, and its use ensures that the cutters and the gear are set to run on truly parallel axes.

To operate the machine, the gear is set up with its axis parallel to the cutter slide by use of the setting slide, and the stroke is adjusted so that the cutters overrun the ends of the gear teeth by about half their width. The cutters are then brought into mesh by advancing the saddle until only slight backlash remains, and they are then advanced individually by means of the fine feed until backlash is eliminated. When the machine is set in motion, successive cuts are taken by advancing the cutters by 0·002in or less per cut. To ensure that an equal cutting action takes place on the teeth, change wheels and a differential gear are incorporated between the drives to the headstock and cutter slide to give a continual creep to the cutter, thereby producing a predetermined pattern of cuts. The cutting action, therefore, follows a cycle which determines when successive cuts should be put on.

The particular advantage of the "Finroc" parallel-axis system of shaving lies in the wide zone of contact between cutter and gear.

Cutters can be made to a very high degree of accuracy, and it is considered that if the cutter and gear are allowed to rotate together freely, and their relative motion is determined only by their own contact and not by any extraneous gearing, then the accuracy of the cutter will be transferred to the gear since excessive metal at any point on the gear teeth will increase the contact pressure at that point and will be shaved off.

To remove undulations of any wavelength on hobbed helical gears, it is only necessary to use a cutter of a width equal to or greater than the axial wavelength of the longest undulation present on the gear. Contact is thus limited in the first instance to the peaks of the undulations which are gradually eliminated.



CUTTERS IN MESH WITH DOUBLE HELICAL GEAR

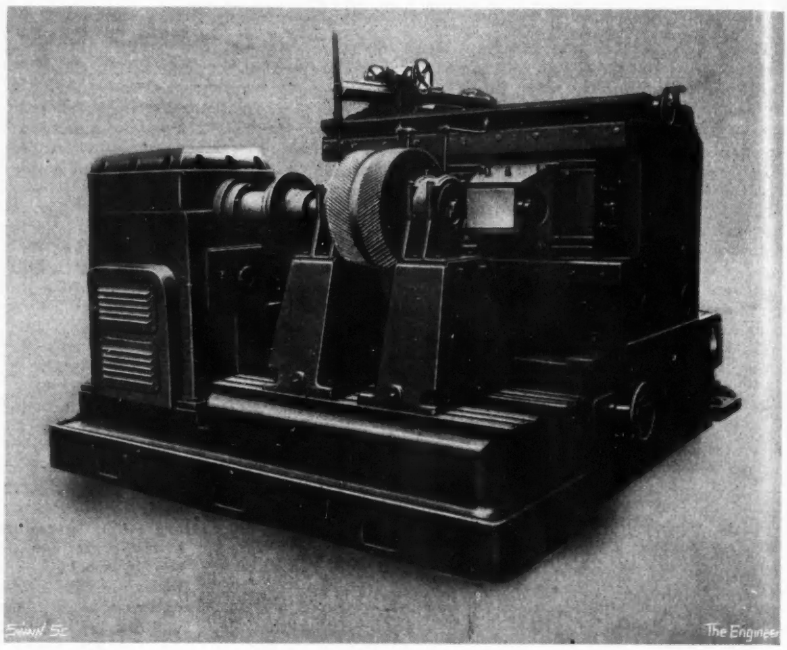
Correction of Profile and Pitch Errors

A common cause of profile errors in hobbed gears is the presence of errors in the hob and in the hob spindle motion, and the same profile error is repeated on every tooth of the gear.

When the machine is operating on such hobbed gears the velocity ratio between the gear and the cutter, which is essentially a mating pinion, will be comparatively uninfluenced by profile error and will depend only on the accuracy of the pitch and helix angle, provided that the width of the cutter exceeds one axial pitch, contact being limited to those parts of the profile where there is excess metal. This uniformity of velocity ratio persists as the excess metal is removed to result in the production of accurate tooth profiles.

The only form of pitch correction which takes place in shaving is an "averaging-out" of errors between teeth which are simultaneously in contact with the cutter. Since contact between cutter and gear takes place over a relatively wide zone, an "averaging-out" of errors takes place within this zone, which results in a considerable degree of correction between adjacent teeth and over short spans.

With a suitable choice of speeds of rotation and reciprocation, a very fine cutting action is obtained, resulting in the removal of long, fine, hair-like chips. The direction of the cut runs at an angle down the tooth profile and cutting takes place in both directions. A very fine finish is produced, similar to that obtained by very fine hand-scraping, with very little burnishing of work-hardening of the tooth surfaces.



"FINROC" GEAR SHAVING MACHINE

Helix Angle Correction

Of all the errors in helical gears, that of helix angle is one of the most serious and also one of the most difficult to control and correct. It is claimed that all helix angle errors can be completely corrected by one of four methods.

First, if a cutter is used having a face width equal to, or exceeding, the face width of the gear, correction of helix angle will be automatic during the normal shaving process. This type of correction will also take place if the cutter has a face width equal to about half the face width of the gear, but its effectiveness is progressively lost when the width of the cutter is reduced to below one-third the width of the gear.

With cutters that are narrower, the correction is not so complete and tends to be confined to the ends of the gear. When a cutter is too narrow for correction to be automatic, the correction can be improved by reducing the stroke of the cutter to a little less than its own width, and confining the action to the central portion of the gear until the angle is partially or completely corrected. The stroke is then gradually lengthened and the correction carried to the ends of the gear.

A second method is only applicable to gears which are intended to run in one direction, as with it the correcting of one tooth flank results in doubling the error on the opposite side of the tooth. To correct this error one flank of the gear is deliberately misaligned in the horizontal plane so that more metal is removed from one of its ends than from the other. If the amount of misalignment is correct, the error in the selected flank can be completely corrected, although the error in the other flank will be approximately doubled.

An improvement in the above method can be effected by using a shaving cutter having cutting edges on one set of flanks only. As before, the gear is first misaligned and one set of flanks is corrected. The gear is then re-set parallel with the cutter slide and the cutter is reversed on its spindle in order to operate on

the second set of flanks. By this method, the errors in both flanks can be corrected.

The two methods described above are applicable, strictly speaking, only when the error in helix angle is uniform. If there is an error which is not uniform and results in local areas of the teeth showing a hard bearing at any particular section of the gear, this can be corrected by using a short stroke of the cutter and limiting the cutting action to the part from which it is desired to remove metal. This presupposes that the hard marking shows all round the gear at the particular section. For this method of local correction, cutters having cutting edges on both flanks, or on only one flank, can be used, depending on whether it is desired to remove metal from both, or only one flank of the gear.

South African Engineering Notes

(From our South African Correspondent)

Water Supply Schemes

The greatest handicap to South Africa's industrial future is water scarcity. It will probably come as a shock to many people outside South Africa to learn (from no less an authority than Mr. S. P. le Roux, Minister of Agriculture) that, in this huge country, only one river—the Vaal—flows the whole year round. Recently, Mr. le Roux stated: "The rest of our rivers are what might be called flood rivers, flowing only after rain. The lack of water is therefore the Union's main problem." In the light of this statement it is not surprising that more money is being spent at present on water schemes than on any other kind of civil engineering project. East London, Port Elizabeth and Cape Town have all well-developed schemes to increase their water supplies, while in the Transvaal a £5,000,000 project has just been announced for the Vaal, whose existing capacity, excluding the needs of the new Orange Free State goldfields, will be absorbed within twenty-five years from now.

An acute water shortage is now being experienced by East London, the Union's fourth port and one of its important industrial areas. Droughts are frequent in this district, but it has been East London's boast that, so far, although householders have been rationed, the supply of water to factories has never been curtailed. But that boast has now gone by the board, as industrial consumers have had supplies considerably reduced and have been warned that if they use up their quotas in less than thirty days their water will be cut off until the start of the next month. This drastic threat has apparently become necessary because the city has only 90,000,000 gallons in reserve, which, after allowing for evaporation and seepages, and for the rationed quota to factories, gives only 500 gallons of water per head of population (or less than 3 gallons a day) until the rainy season starts in October.

East London hopes its water problems will be solved when the Laing dam is completed before the end of this year. This dam, which will have taken four years to build, will provide a storage capacity of about 5,450,000,000 gallons, and give an assured gross supply of 11,000,000 gallons a day. As East London's daily consumption is 2,250,000 gallons, the new dam should be sufficient to meet the city's needs for many decades to come.

Rand Water Board

Faced with the rapid industrialisation of the whole Witwatersrand and of both Pretoria and Vereeniging (where Africa's first oil-from-coal plant will be established), plus the future demands of the new Free State gold mines, the Rand Water Board has decided to establish a new pumping station and purification plant above the confluence of the Suikerboschrand and Vaal Rivers near Vereeniging. The estimated cost will be £4,876,800. The site, 400 acres in extent, has been purchased by the Board for £45,000, and will accommodate a station with a maximum capacity of 240,000,000 gallons, compared with the existing Vereeniging works capacity of 123,000,000 gallons daily. The preliminary plan for the new station, which will be called Zuikerbosch, provides for an arrangement of plant in units of 80,000,000 gallons each. To ensure proper and easy supervision and economy of labour, the intake station, main pumping station, workshops, main stores and administrative offices will be housed in one central building on the bank of the river close to the point of abstraction, and the intake station will be connected by a tunnel with the river. Three motor-driven centrifugal pumps, each with a capacity of 21,000,000 gallons daily, will pump the water from the river to the purification plant.

To-day the Rand Water Board is supplying the largest concentration of population in South Africa (more than 2,000,000 people in an area of 3980 square miles) with a daily average of 85,017,000 gallons. This water is stored by the Vaal River barrage, some 23 miles below Vereeniging, and by the Vaaldam, which is about 50 miles upstream from the barrage. There is, probably, no water undertaking of equal size which has to rely so entirely on pumping plant to maintain a continuous supply of potable water. As the difference in level between the Vaal River barrage and the Yeoville (Johannesburg) reservoir is 1300ft, a total pumping head of nearly 2000ft is necessary to obtain a satisfactory hydraulic gradient. Nor is this all. The pipe-line distance between these two points is 40 miles, which makes direct pumping uneconomical Consequently, more than 90 per cent of the water delivered to the Witwatersrand has to pass in series through four sets of pumps and about 10 per cent through five sets. To secure a continuous supply of water a total of 150,000 h.p. capacity pumping plant has been installed. Flow records from the Vaal show that there is sufficient water to provide only 250,000,000 gallons daily. Allowing only 50,000,000 gallons of non-potable water for industrial users abutting the Vaal River, it is estimated that consumer demands will absorb the rest of the Vaal's capacity by 1975—a calculation which makes no provision for the undoubted heavy requirements of the Free State mines. As Mr. J. P. Leslie, chief engineer to the Rand Water Board, has said in his last annual report: "The supply of water is the controlling factor in the future economic development of the country. The low total rainfall, the uneven distribution over the year, the occurrence of droughts, the extreme variation in the rate of precipitation, the high rate of evaporation and the absence of suitable storage sites present a problem that will not easily be solved. The sooner we realise that our South African cornucopia holds little water, the sooner we shall take steps to conserve, to protect and use to the best advantage and without waste, the little we have of this most precious gift of the gods."

The Economic Situation

Reports show that the financial world generally approves the drastic restrictions now imposed by South Africa on all imports. But the effect of these cuts on the export drive of Britain's engineering industry, it is considered here, is bound to be serious. The Acting Minister of Economic Affairs, Dr. Donges, in announcing these new restrictions, said: "The Government regards the importation of essential capital goods for mining, agriculture and other basic industries as of primary importance for maintaining our economic life during the difficult months ahead." Despite this assurance, however, the fact remains that temporarily the volume of these essential imports from Britain will be at least halved. An analysis of the Union's trade position shows that the worst effects of import control ought to be over by the end of this year, and South Africa should then be able to ease its restrictions and live a reasonably comfortable life within its £250,000,000 annual income. The immediate situation is serious owing to a delay in introducing adequate controls, and this year already £170,000,000 has been spent overseas out of the £250,000,000 available. To tide the Union over the second six months, the outstanding £45,000,000 of the British loan will almost certainly be recalled, making about £130,000,000 available for overseas purchases until December. This calculation does not touch any of the remaining £42,000,000 gold reserve.

From the beginning of 1950 South Africa will start with its gold production of £100,000,000, and its exports of wool, fruit, diamonds, canned food, manufactured goods, &c., of about £150,000,000. From this figure must be deducted about £30,000,000 for invisible imports, leaving £220,000,000 for goods. This figure for available expenditure represents about three-quarters of what the Union imported during 1947, when people were buying motor-cars, refrigerators, radios and similar expensive items which had become short during the war. But such a high rate of purchases is not going to be repeated for some years. Three-quarters of the 1947 total imports, therefore, will not, it is considered, represent any particular hardship for industry here, and, in view of Dr. Donges' statement given above, should certainly allow for a normal importation of engineering equipment from Britain. But a number of factors are left out of this analysis. A favourable one is that the calculations make no allowance for any tangible resumption in the flow of sterling investments in South Africa. Adverse considerations that have been mentioned are, first, that general world restrictions may cut oversea earnings (including raw materials) down to a much lower figure than £150,000,000; secondly, that six months of serious deflation may prove sufficient to produce large-scale unemployment here and that it, snowball-like, will bring more and more depression with the result that factories will close down and production drop—thus also affecting the annual income, a picture generally regarded as unnecessarily pessimistic. Certainly one immediate result of the complete embargo on consumer goods of all types must be that, despite cuts in raw materials and equipment, manufacturing industry here will try to replace the banned goods in an effort to gain the local market permanently. Already Mr. de Waal Meyer, Secretary for Commerce and Industries, has told industrialists to make only quality goods and "to shun the manufacture of rubbish." Mr. de Waal Meyer said he hated controls as much as anybody, but they were now necessary. Encouraging factors affecting the present economic situation were enumerated by him as the easing of the present cement and steel shortage in the near future when new cement factories and the Iscor strip mill came into production, and the "trickle back" of oversea capital. He admitted, incidentally, that the flow of capital had stopped due to lack of confidence.

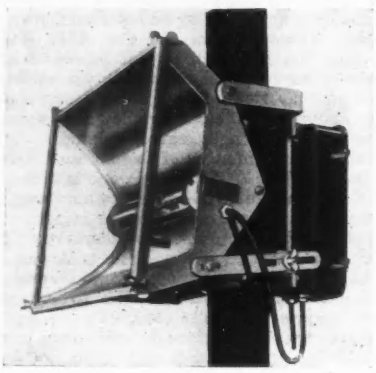
Skilled Labour

Also in conference recently was the Association of Municipal Electricity Undertakings of Southern Africa. Here the President, Mr. D. A. Bradley, recorded his Association's perturbation at the shortage of skilled labour affecting the development of electricity undertakings throughout the country.

His suggested solution to the problem, now that the flow of trained artisans from Britain has virtually ceased, was the training of an increasing number of apprentices. Labour problems have been worrying industry generally and the president of the Transvaal Chamber of Industries, Mr. A. A. Menkin, has given a Press interview in which he advocates a system of incentive bonuses for industrial workers. "The average standard of efficiency in industry in South Africa is considerably below that of other countries," Mr. Menkin declared, "and the way to improve it is by means of incentive bonuses. Our productivity must increase if we are to hold our own with other countries." While statements from members of the present South African cabinet have revealed Government sympathy with Mr. Menkin's suggestion, most of the important trade unions in this country have strongly opposed the proposal, and it would seem that, at the moment, the unions have the Government's ear.

Sodium Approach Light for Horizon Bar Landing Systems

In the visual aid to landing in bad visibility known as horizon bar lighting, pilots judge their nearness to the runway and the attitude of the aircraft by observing successive bars of lights arranged at right angles to a line of high-intensity approach lights. The system, which was described in THE ENGINEER, April 30, 1948, page 420, was developed at the Royal Aircraft Establishment, Farnborough, by Mr. E. S. Calvert, B.Sc., and uses three groups of lights per bar, the number of lights in the central group decreasing as the runway threshold is approached. Any individual bar in view may serve as an artificial horizon,



SODIUM APPROACH LIGHT

and since the overall length of the bars decreases towards the runway, a pilot flying so that all appear to be the same length as they pass under the nose of the aircraft knows that he is losing height at the correct rate.

A new light has been designed by the General Electric Company, Ltd., to take the sodium lamps used in installations of this kind. As shown in the accompanying illustration, a 140-W sodium lamp is mounted horizontally in front of a reflector of super-purity anodised aluminium, the assembly being clamped between cast alloy end pieces. A "Perspex" panel in front of the lamp and windows of the same material in the end pieces ensure a wide horizontal spread of light. The light is carried in adjustable mounting stirrups and is provided with a level to indicate the elevation of the beam. The clamps for attaching the light to a post also carry a weatherproof case containing the transformer, fuses and capacitor for power factor correction.

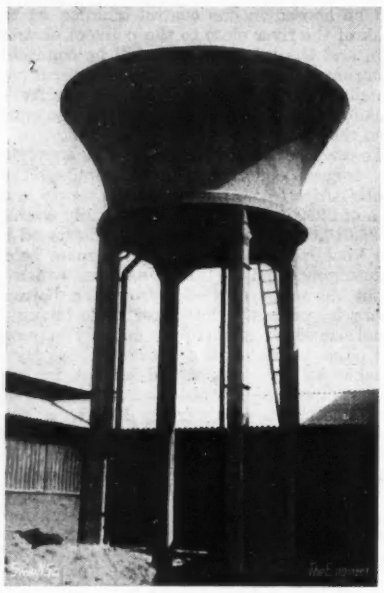
A Pre-Stressed Concrete Water Tank

An interesting example of pre-stressed construction has recently been built by the Société Marseillaise d'Entreprises et de Constructions, the details of which we reproduce from *Le Génie Civile* of May 1st.

In the construction of a cylindrical water tank in reinforced concrete, the amount of steel reinforcing and the thickness of the concrete are governed more by the necessity of obtaining an impermeable surface, free from cracks due to the extension of the steel, than by the need to resist structural stresses. With a pre-stressed tank, however, if the concrete has a residual compression when the tank is full, cracking is eliminated, and watertightness can be obtained with a relatively thin wall of concrete, and with the minimum of steel necessary for structural purposes.

However, the pre-tensioning of wires, which are placed circumferentially round a cylindrical tank, is very awkward. This difficulty has been overcome by forming the tank as a hyperboloid of revolution, which is a surface generated by a line rotating round the base circle of the hyperboloid. This generating line is inclined at 45 deg. to the vertical, and at any given position is situated in the vertical plane through the tangent at the point of contact of the line with the base circle. The resulting shape is clearly shown in the accompanying illustration.

By using this shape, it is possible to position a network of straight pre-stressing wires, at 45 deg. in both directions, along the generating



PRE-STRESSED CONCRETE TANK

lines. The concrete is thus compressed in all directions, and impermeability is assured. Similarly, the shuttering can be simply fabricated from straight elements disposed along the generating lines.

Tanks of 40 cubic metres capacity have been constructed on this principle, the lower diameter being 3·75m, the upper diameter 6m, and the depth 2·45m. The thickness of the concrete wall of these tanks is only 3cm. The reinforcement consists of hard steel wire of 3mm diameter, pre-tensioned to 100kg per square centimetre, and the concrete stress is 30kg per square centimetre. The thin hyperbolic shell is not built into the base, but rests upon it, a special joint being incorporated to permit deformation and ensure watertightness.

The shuttering is relatively costly, since it must be accurately formed and strong enough to resist the forces in the pre-stressing wires, which reach about 100 tons without appreciable deformation. However, if a number of tanks are required, the shuttering can be re-used. Only the outside hyperboloidal surface of the tank is shuttered, and the concrete is thrown into this shutter like a coat of plaster. The pre-stressing wires are fitted at their ends with special anchorage pieces to guard against possible insufficiency of bond between the concrete and metal.

German and Japanese Battleships*

By DR. OSCAR PARKES, A.I.N.A.

No. II—*Continued from page 41, July 8th*

"YAMATO"

Armament.—Nine 18in guns in three triple turrets constituted the heaviest main armament ever mounted on shipboard, although two Japanese 48,000-ton battleships and four 46,000-ton battle-cruisers, whose construction was discarded under the Treaty of 1923, were to have been armed with eight 18in guns.

Set back 238ft from the bow, the axis of the guns in "A" turret swung some 37ft above the water-line (5ft higher than those in the "Hood") and the "B" guns were 47ft. Owing to the rise in freeboard amidships, which was carried well aft beyond "C" turret, the guns here had a command of 42½ft, over 5ft more than in "A" position. This sequence of relative heights in a three-turret ship stands out as unique in the history of battleship design.

The "Yamato's" guns were 45 cals. long (70ft), weighed 162 tons each, and fired a 3220lb shell with 728lb of propellant at 2550ft per second. The high-explosive shell was 3000lb with a muzzle velocity of 2640. Rate of fire at a maximum elevation of 40 deg. averaged one and a half rounds a minute with a range of 45,960 yards. Her turrets were the most massive ever constructed, with 25½in faces, 20in sides, 9 to 10½in crowns and 7½in rear plates, except "B" turret, where for counterbalancing it was increased to 18in. The barbettes were 19·4in thick between decks and 21·6in above them, the diameter of the roller paths being 42ft 8in externally. Training rate was relatively slow, being 2 deg. per second. The arrangements for ammunition supply were unusual, half the projectiles for each triple group being stowed on the rotating turret structure.

Calculations covering the turrets and mountings were not made *de novo*, but arrived at by comparison with the data of those which had not failed in service. Thus, the 14in turret in the battleship "Ise" had been scaled up for the 16in "Nagato" design, and the same process applied to the "Nagato's" structures served for the "Yamato."

As originally designed she carried a secondary armament of eight 8in guns in four twin turrets, one fore and aft and one on each beam.

But when the "Mogami" class cruisers were re-armed with 8in guns, two triple 6in from these ships were transferred to the "Yamato" and "Musashi," one trio being placed at each end of the superstructure firing over the 18in turrets. These small turrets had 3in faces and 1in sides and roofs, with a 3in barbette rising from the armour deck. The guns, with 70 deg. elevation, served as medium-range anti-aircraft, the ammunition being man-handled, which must have meant selected crews, the Japanese having adopted the 5·5in piece for their later battleships, because the 100lb shell proved too heavy for the average gun number.

It is hardly surprising that these lightly-armoured gun-houses proved to be the weak spot in the design, the after one being the Achilles heel in the "Yamato," exposing the magazine to the after effects of a 2000lb bomb.

The superstructure was devoted entirely to the accommodation of anti-aircraft guns in small turrets, sponsons, and gun-pits carried at various levels, interspersed with their control positions. When first completed the sky defence was modest, only twelve 12·7cm and sixteen 4·7cm, as shown in the top view in Fig. 3.

Aerial photographs taken in October, 1944, show that this arrangement had been extensively modified, the wing 8in turrets having been removed and replaced by a shelter deck carrying the 12·7cm in small twin turrets. Above them the three sponsons now held triple 47mm, with additional twin 25mm mounts on deck and two aside at the deck edge abreast the first and third 12·7cm turrets.

After this action the armament was again increased, and her final photographs show a line of five twin 25mm along the deck edge, two gun-pits on "B" and "C" turrets, and additional twins on deck.

Originally, four searchlights were grouped on each side abreast the funnel, but it is difficult to determine whether the domes shown in the "Yamato" 1944 photographs are projectors or not. In the plan, Fig. 3, they are so shown, but ultimately single guns are said to have been substituted.

Aircraft.—The provision of an aircraft hangar beneath the quarterdeck accounted for the height to which this was maintained in contradistinction to usual Japanese practice. Four planes are said to have been carried, and a catapult was provided right aft on each side, with handling rails taken forward to abreast of "C" turret. The official plan shows a break of the deck at the fore side of the lift, but photo-

* Institution of Naval Architects, Summer Meeting at Edinburgh. Abstract.

graphs in 1944 suggest that the deck and sides were moulded as here shown. On first completion there seems to have been a wide splay on each side of the quarterdeck which throws the shadow seen in the trials photograph; also a break in the deck right aft can be seen beneath the lattice radio mast.

According to one correspondent, the embrasures aft were used to convey the one man submarines to operational areas.

Protection.—The scheme of protection entailed the use of very heavy armour and an unusual system of its distribution, considerable originality being shown in the system of sloping armour on the hull sides, in the subdivision, and in the method of protecting the magazines against under-water explosion.

The 16in side armour covering the magazines and machinery spaces was inclined at 20 deg. from the vertical along the water-line, below which it tapered from 10½in to 7in. Amidships it rose to the level of the main deck only, but was taken up a deck higher beneath the forward turret. This country had introduced sloping armour in the "Hood," whose sides showed a 10 deg. inclination, and the latest United States designs also incorporated this feature, but for all that the "Yamato" system must be regarded as a bold adaptation (Fig. 4).

There was no protective deck rising from the lower edge of the belt such as had been universally employed against gunfire for the past fifty years. Instead, the horizontal protection was concentrated on the main deck at the level of the upper edge of the belt, a reversal to the earliest practice in ironclads, being 7½in on the flat portion towards the middle line and 9in on the slightly sloping sides. The citadel was closed fore and aft by curiously angled bulkheads 13in thick forward and 12in aft, (middle view, Fig. 3).

Special under-water protection beneath the magazines was afforded by 2in plating sloping downwards from the lower edge of the belt to a point well beneath the barbettes where it became 3in horizontally. The longitudinal armour bulkhead was a downward continuation of the side belt and served as the holding bulkhead of the under-water protection. This method of defence against mine or torpedo recalls Sir Edward Reed's efforts to introduce something of a similar nature in 1884, when he tried to get his U-shaped armoured double bottom accepted by Sir Nathaniel Barnaby for incorporation in the "Sans Pareil," but without success. Very strong protection was given to the steering gear, both rudder heads being boxed in with 14½in plating at the sides, 7·9in on top, and 13 to 13·8in at the ends, thicknesses far exceeding the practice in H.M. ships.

Vertical and side armour was made into a unit by tongue-and-groove connections, with wood as an armour backing. Compared with practice in this country there was judged to be some weakness in the connection between the upper and lower side armour strakes.

This under-water defence system was designed from the tests carried out when the battleship "Nagato" was modernised. Full-scale caissons and small scale models were used, the latter being one-third to one-fifth scale as the full-scale joints could not be represented in a smaller size. The system was designed to withstand a charge of 400kg.

Tests had shown that air-backed shell plating was quite as effective in preventing damage from under-water attack as when backed by water or oil, hence the outboard layers of the torpedo defence system were carried void. No special care was taken to avoid hard spots which might cause punching under explosive loadings, and there were no curved transmission bulkheads. All material was riveted, as no effective welding system had been developed for the type of steel used.

Subdivision.—A central longitudinal bulkhead ran between the engine and boiler rooms, dividing these into two groups with six boiler rooms and two engine rooms.

Decks rose and fell to a remarkable extent which would have delighted an Elizabethan shipwright. Heights varied from 12ft to 5ft or less, and the bunching at the after bulkhead is noticeable (Fig. 3).

Stability.—The degree of stability necessary to preserve flotation after flooding was based upon the following calculations:—

(1) With all the unprotected spaces in the ship flooded the volume of the armoured citadel above the damaged water-line should still be from 20 to 25 per cent of the total volume of the citadel. In this condition there must be a positive G.M.

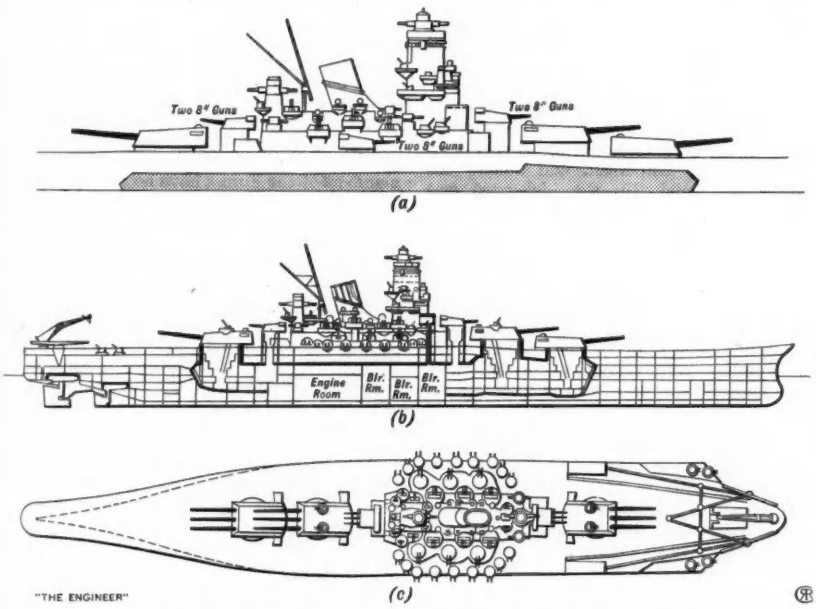
(2) With all the torpedo protection spaces on one side flooded as well as the unprotected ends, the ship must have positive G.M. and must not capsize.

As ample beam was regarded as the controlling form factor in determining a high degree of buoyancy, the width amidships was retained over the whole section between turrets "B" and "C." To assure an acceptable range of stability, the flying deck was laid as high as possible amidships, although this represented unarmoured stability only.

In their battleships the Japanese considered the following figures acceptable:—

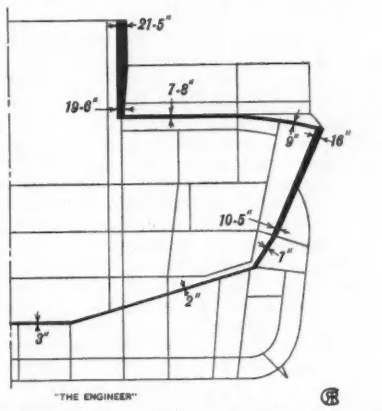
G.M.=8·7ft; maximum G.Z.=3·8ft; range, 70 deg.; period of roll, 16-18 seconds.

In the "Yamato," at trial displacement of 69,100 tons, the actual figures were: G.M.=10-11ft, G.Z.=7ft (7·7ft maximum) at 38 deg., which are quite remarkable figures. Her range was 72 deg. and period of roll 16 seconds.



(a) To show the 8in gun turrets, A.A. gun distribution and armour belt as first commissioned, 1941
(b) To show armour decks over steering positions, barbettes, and beneath magazines
(c) Showing final distribution of A.A. guns

FIG. 3—*"Yamato"*



Showing thick armour deck at upper edge of belt, and horizontal armour beneath magazine.

FIG. 4—*"Yamato," section through "B" turret*

It is stated that one of the factors contributing to the higher G.M. than is usual in British battleships was the centre-line bulkhead in the machinery spaces, which required considerable initial stability in order to limit the angle of heel after damage, when a machinery space on one side might be flooded.

Propulsion.—A maximum speed of 27·7 knots was attained with 158,000 s.h.p., from four sets of geared turbines driving quadruple screws. The cruising speed was 18 knots with 25,000 h.p., at which she could cover 10,000 miles. Some 5000 tons of oil fuel could be bunkered.

It will be noted that the funnel uptakes had to be taken aft beyond the third group of boiler rooms in order to keep the tower clear of furnace exhaust. There is no record of the protection given to the splayed out uptakes between decks.

General.—The trials photograph shows lifeboats just forward of the twin 8in turret and abreast of "C" turret, but in action photographs she is without boats. It is possible that the Japanese dealt with the difficult problem of boat stowage in the same way as did the Americans, discarding them in favour of a boat pool at the operational bases. Boats mean weight and space which can be put to better military use, and except for a lifeboat Japanese ships have been without them for the past ten years.

The "mast" was an almost rectangular tower rising twelve stories above the flying deck to a height of 125ft from the water-line. A central communication tube ran down from the top control position to the armour deck. The tower contained the admiral's, chief of staff's and captain's sea cabins, officers' and warrant officers' cabins, chart house, signal house, D.F. house, control and plotting offices, navigation house, submarine look-out positions, &c.

Conclusion.—To-day it seems that the "Yamato" must be the final development of the big-gun-carrying battleship, wellnigh impregnable and unsinkable by gun-fire, and capable of dealing far heavier blows than she would have received. As such, and from an academic point of view, it is to be regretted that she and her sister never matched their might and strength against that of their peers. As it was, the "Yamato" was hit by nine torpedoes from aircraft and about as many bombs, and "Musashi" by nearly double that number, before being sunk. That the ships were expended to little purpose was due to faulty strategy; their constructors certainly seem to have made the most of the displacement and turned out incredibly powerful fighters.

Industrial and Labour Notes

Non-Ferrous Metal Prices

At the beginning of the week, the Minister of Supply, Mr. G. R. Strauss, announced some further reductions in the British selling prices of copper, lead and zinc, to bring them into line with current prices in the U.S.A. The new prices, per ton delivered, are as follows, the extent of the latest reductions being shown in parenthesis :—electrolytic copper, £107 10s. (£10), good soft pig lead, £75 10s. (£6 10s.), good ordinary brand zinc, £58 (£20). Discounts and premiums remain unchanged. The Ministry of Supply's buying price for rough copper in slabs of from 2 to 3 cwt has been reduced from £80 to £70 a ton. The prices of zinc oxide have also been reduced to the following figures per ton, for lots of not less than two tons delivered to buyer's premises : red seal, £58 15s. (£17) ; green seal, £60 5s. (£17) ; white seal, £61 5s. (£17). All these new prices became effective on July 12th.

In making these price changes, the Ministry of Supply states that the Exchequer will have to bear a loss, the size of which depends on how future price movements affect the values of stocks in hand. On account of the present unstable nature of the non-ferrous metals market, the Ministry has instituted a new arrangement for forward purchases, under which users can continue to buy forward up to six months' requirements for copper and zinc and up to three months' in the case of lead. Buyers will, however, have to pay a premium as an insurance against a rise in prices. The additional charges, per ton, on orders booked for forward delivery are : copper, £2 10s for delivery in the second and third calendar months after month of ordering, and £5 for delivery in the fourth, fifth and sixth calendar months ; lead, £2, for delivery in the second and third months ; zinc, £2, for delivery in the second and third months, and £4 for delivery in the fourth, fifth and sixth months. Orders for copper and zinc will not be accepted for delivery more than six months after the end of the month of ordering, or for lead for more than the period of the quota, at present three months, under the rationing scheme. Sales for delivery in any one calendar month are to be limited to a quantity not substantially exceeding the customer's normal monthly consumption.

In addition, the Ministry says that licences to acquire copper and zinc are now granted only if accompanied by (i) a declaration that the metal is required to cover orders, (ii) a declaration that in the case of applications for virgin metal full allowance has been made for the expected intake of scrap, and (iii) the usual purchase order on the Directorate of Non-Ferrous Metals, giving details of specification, delivery, &c., required, or a statement that the applicant intends to purchase from a stockist. This means that the conditions attaching to licence applications, which were suspended on June 1st, have been re-imposed.

The London Metal Exchange

The London Metal Exchange, which was closed on the outbreak of war in 1939, was the subject of further questions in the House of Commons on Monday last. Replying to them, the Minister of Supply, Mr. Strauss, said that he had now carefully considered commercial and industrial representations which had been made on the advantages of re-opening the Exchange. It was, however, generally accepted that a free market in non-ferrous metals would have to be severely restricted to prevent a loss of our dollar resources, and he was convinced that those limitations, if they were to be effective, would so restrict the freedom of the market as largely to nullify the benefits which its advocates desired to bring about.

What was even more important, Mr. Strauss added, was that the abandonment of bulk buying of non-ferrous metals from Commonwealth countries would seriously endanger our supplies from those countries and make us more dependent on dollar purchases. For those reasons, he stated, he was at present unable to agree to the re-opening of the Metal Exchange for the purchase and sale of copper, lead and zinc. Other considerations, Mr. Strauss said, applied to tin, which was now the subject of international discussion. He had not, therefore, reached any conclusion about the future marketing of that metal.

Iron and Steel Production

Figures published this week by the British Iron and Steel Federation reveal that, in the month of June, British steel output averaged 300,900 tons of ingots and castings a week, which represents an annual production rate of 15,645,000 tons. Over the second quarter of this year, steel production has been running at an annual rate of 15,944,000 tons, and taking the first six months of the year, the average annual rate of output has been 15,897,000 tons. The total amount of steel ingots and castings produced in the six months ended June 30th was 7,949,000 tons, the highest half-yearly output ever achieved in this country.

Pig iron output in June averaged 185,800 tons a week, which represents an annual production rate of 9,664,000 tons. During the half-year, January to June, pig iron output averaged 181,600 tons weekly, or an annual production rate of 9,442,000 tons. The annual rate of output during the corresponding period of 1948 was 9,274,000 tons.

The National Union of Mineworkers

The annual conference of the National Union of Mineworkers was continued at Porthcawl throughout last week, and among the addresses delivered to the delegates was one, on Wednesday, by Lord Hyndley, chairman of the National Coal Board. He said that the year 1948—the coal industry's second year under public ownership—had brought some successes and disappointments. Although in sight of the production objective, it had not been reached : another 2,500,000 tons would have "done the trick." But, Lord Hyndley commented, to be left with a small financial surplus after the heavy deficit of 1947 was encouraging, although there would have been another deficit had it not been that the world price of coal had enabled us to export profitably last year. As it was, most of the deficit incurred in 1947 was still there—to the extent of £22,500,000—although, Lord Hyndley suggested, it was not beyond the industry's capacity to wipe it out inside twelve months from now. The only way to do the job, he said, was to increase production and cut down costs. Let there be more shifts worked and more coal produced on each shift.

Later in his speech, Lord Hyndley referred to the matter of wages and production costs. Although the Board had not been able recently to agree to certain proposals made by the union for the further improvement of wages or conditions, he hoped there would come a time when the industry, by its consistent efforts, would have made it possible for a different answer to be given. The need to curb costs, in the interests not only of the coal industry's but also the country's future, must be ever present in the minds of the union's representatives and of the Board in discussing the problem of the industry's wages structure. No one who knew the facts, Lord Hyndley went on to say, would deny that the wages structure required improvement, and it was a complex problem about which both the Board and the union justifiably felt great concern. He had to make it clear, however, that no revision of the wages structure could be acceptable which, in the present circumstances, increased wages costs. From all points of view, therefore, now was the time for an all-out effort to increase output and cut costs. Production, Lord Hyndley added, during the first half of this year, had been better than last year by about 2,700,000 tons, but it could, and must, be improved upon.

London Dock Strike

An unofficial strike in various sections of the London docks has now been in progress for about three weeks, and, as we go to press, it is reported that over 13,000 men are idle. The cause of the stoppage is obscure, the strikers claiming that their action is in sympathy with a dispute in which the Canadian Seamen's Union is involved. They refused, however, to unload two Canadian ships in the Port of London, and subsequently the dock employers, following arrangements made under the dock labour scheme, stated that they could not engage dockers for ships coming into the port until the Canadian vessels had been cleared. The majority of the men concerned are members of the National Amalgamated Stevedores and Dockers Union, and appeals for a resumption of work by that union and the Transport and General Workers Union have so far been ignored by the strikers.

Although at the beginning of this week the number of men continuing at work in the Port of London was 15,000, this unofficial stoppage has naturally led to delay and congestion in the handling of important cargoes. Following a meeting of the Privy Council on Monday morning, a Royal Proclamation, issued under the Emergency Powers Act, 1920, declared that a state of emergency existed in the Port of London. Regulations for dealing with the emergency became effective almost immediately, and, under the direction of the Government, members of the Forces have been set to work in the docks.

Railway Wages

The discussions on the railway wages dispute were resumed on Friday last between officials of the Ministry of Labour and representatives of the Railway Executive, the three railway unions, and the Confederation of Shipbuilding and Engineering Unions. At the conclusion of the talks, Sir Robert Gould, the Ministry's chief industrial commissioner, stated that the Minister of Labour would invite the parties concerned to consider the points at issue with a Board of Conciliation. The principal problem to be settled, it may be recalled, is the claim advanced by the National Union of Railwaymen for a general wage increase of ten shillings a week and additional payment for Saturday afternoon work.

It was explained on Saturday last that the Board of Conciliation would be set up as soon as the Minister received from the parties concerned their official intimation that they would participate in the proposed procedure. Five independent members to be appointed by the Minister would constitute the Board which would have the following terms of reference :—"To assist the parties in the consideration of their present problems relating to salaries, wages and conditions of service in the industry, arising from the recent meetings between the Railway Executive and the trade unions ; to endeavour to promote an early settlement of the said problems by negotiations between the parties ; and, failing a settlement on any point, to make recommendations which the parties agree beforehand to accept." It was understood that if the last clause of these terms of reference had to be operated, the Conciliation Board would be assisted by one assessor from each of the parties concerned.

French Engineering News

(From our French Correspondent)

Since the suggestion that de-nationalisation of the French aeronautical industry should take place in order to obviate the constant need for subsidies, there has been a stream of protests from workers in the industry, while at Billancourt the factories were occupied by workers who refused to leave. Since then a respite has been won, but in the annual report on the direction of the nationalised industries, Monsieur Poullenc has stated that the liquidation of the State-owned aeronautical industry would completely disorganise the whole of the industry. He points out that the S.N.C.A.C. (nationalised factories) was reorganised in May, 1948, when the deficit was running at about 58 million francs per month, and four months later operating methods were simplified and industrial concentration took place. The monthly deficit is now only about 20 million francs. Improvement continues, there has been progress in output and personnel has been reduced, so that 1949 seems likely to produce a profit. However, the refusal by the government to increase capital has gravely hindered the working of the company, which has even had difficulty in meeting salaries. Monsieur Poullenc stresses the point that liquidation of the S.N.C.A.C. would entail enormous expenditure, compromise important research and deprive the country of an important contribution to technical progress.

Following an all-night debate on the aeronautical industry, the National Assembly has decided that the S.N.C.A.C. must disappear under its present form but certain of the study bureaux and factories will be maintained. About ten factories will be sold or transferred to another nationalised company and personnel will be reduced to 34,000.

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Although, generally speaking, the French mechanical industries are experiencing the same slowing-off in orders as other branches, the largest companies have assured work. Missions sent by the Fives-Lille company to Spain, Egypt, South America and the French Union have brought back important orders for sugar refining plant and orders taken in 1948 for locomotives, travelling cranes, coking oven equipment, electric motors, boilers and material for the oil industry will keep the company busy. Nevertheless, new orders are noted as being less in volume than deliveries. Everywhere delivery periods are dropping to five or six months, according to the type of equipment. Most affected are firms working for the S.N.C.F. The Société Nouvelle des Ateliers de Venissieux, which specialises in rolling stock repairs, is now in a difficult position due to reduction of S.N.C.F. credits, necessitating a reorganisation of work and partial dismissal of staff.

Reduced orders are also causing anxiety among rolling stock constructors in the Nord. Some of the large plants, such as Tilleul, find it impossible to switch over to smaller work. At the moment the firm employs 1100 workers. Work has been organised on a mass-production system. During the construction of a recent batch of 975 wagons, the trucks were lifted at each end by jacks, into a jig, the body and framework being turned together for welding. Four wagons a day were completed. Other orders recently completed include thirty passenger coaches for the Cameroons, 150 mechanically emptying trucks for the mines and ore trucks for a metallurgical company. The normal monthly production of about 450 vehicles demands regular orders and the plant has been highly specialised to meet such demands, which makes it impossible to turn to other activities.

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Owing to the fact that credits for 1949 are not sufficient to cover all hydro-electric construction started, Electricité de France has had to stop work on the Chaudanne barrage temporarily. Negotiations are being carried on, designed to resume the work, but this will depend on supplementary credits being voted.

Notes and Memoranda

Rail and Road

RAILWAY WORKSHOPS FOR PRETORIA.—It is reported that preparations are now being made, on a site extending over 1000 acres, for the construction of railway workshops at Koedoespoort, near Pretoria. The costs of the new shops, excluding their equipment, is estimated at £5,500,000.

BRITISH RAILWAYS' DIESEL LOCOMOTIVES.—Following recent satisfactory trials, Britain's first main-line twin-diesel electric locomotives (Nos. 10,000 and 10,001) began a regular non-stop service on Sunday, July 10th, to and from Euston and Glasgow. The twin locomotives haul the 9.5 p.m. train from Euston and return the next morning from Glasgow at 10.0 a.m. drawing the "Royal Scot."

LONG-DISTANCE ROAD GOODS TRANSPORT.—The Ministry of Transport announces that up to last week-end 1145 applications had been made to the Road Haulage Executive for "original" permits to carry goods for hire or reward outside the 25-mile radius fixed by the Transport Act. It is estimated that a further 9000 hauliers have obtained application forms which have not yet been completed and returned. The last day for lodging applications with the Road Haulage Executive is Tuesday, August 2nd, and the Ministry of Transport reminds hauliers who are entitled to protection under the Transport Act that they will lose valuable rights unless they apply within the time allowed.

NORWICH RAILWAY ACCIDENT REPORT.—The Ministry of Transport has now published the report of the inquiry conducted by Lieut.-Colonel D. McMullen, an Inspecting Officer of Railways, into the accident on February 3rd at Norwich (Trowse) station in the Eastern Region of British Railways. The 6.25 a.m. Norwich Thorpe to Ely up passenger train when leaving platform one at Norwich Thorpe station was routed accidentally on to the down line and, after travelling three-quarters of a mile past three signal boxes, collided head on with the 2.55 a.m. Whitemoor to Norwich freight train which was standing opposite the fourth box, Trowse Yard. The drivers of both trains and the fireman and guard of the freight train suffered minor injuries. The Inspecting Officer's conclusions are that the signalman who failed to set the road correctly for the departure of the passenger train must be held primarily responsible for the accident. He adds that "had any one of four railway servants on the passenger train or two signalmen been sufficiently alert to notice the incorrect routing of the train, this accident would have not occurred."

GERMAN RAILWAYS, 1939–1945.—B.I.O.S. Overall Report No. 16, which has just been published by H.M. Stationery Office, deals in great detail with the developments in the Deutsche Reichsbahn, during the years 1939 to 1945. The various matters covered are track construction, sleepers, track maintenance and renewal, permanent way shops, bridges and structures, painting of structural steelwork, structures in general, soil mechanics, piles, tunnels, signalling, telecommunications, suburban railways and rolling stock. It is shown that a great many of the wartime developments in German railway engineering were conditioned by the necessity of overcoming the difficulties of Allied bombing, and, in conjunction with the Russian winter campaigns, led to the development of such technically interesting features as the K.52 locomotive. A total of nearly 5,000 locomotives of this type were built, and in practice they proved highly satisfactory. The whole field of civil, mechanical and electrical engineering as it affects railway work is surveyed in this report, which has been edited by Mr. H. Holcroft, M.I. Loco. E., editor of *Railway Engineering Abstracts*. The price of the report is 3s.

Air and Water

AN AERONAUTICAL TECHNICAL SCHOOL.—The de Havilland Aeronautical School has recently celebrated the twenty-first anniversary of its foundation. The headquarters of the school have been moved recently to Astwick Manor, near Hatfield, Herts, where a new workshop and modern drawing offices have been built. Nearly 1000 apprentices are receiving training at the school.

UNITED KINGDOM AIRPORT TRAFFIC.—The Ministry of Civil Aviation has reported that, during the month of March, over 96,000 passengers on scheduled air services and international charter flights embarked and disembarked at United Kingdom airports reporting to it. In addition, over 3,500,000lb of freight and 1,500,000lb of mail were handled. There were 30,217 aircraft take-offs and landings, of which over 10,000 were air transport services.

Miscellanea

COPPER STOCKS.—A written reply by the Minister of Supply states that the Ministry's stocks of virgin copper, including stocks aboard and afloat, amounted on June 30th, to approximately 170,000 tons.

INCORPORATED PLANT ENGINEERS.—The Institution of Incorporated Plant Engineers has issued a four-page pamphlet setting out the qualifications necessary for membership and giving precise details of what the Institution aims to do for the individual works and plant engineer. Copies of the pamphlet can be obtained from the General Secretary of the Institution, 48, Drury Lane, Solihull, Birmingham.

OBITUARY.—We have learned with regret of the death, on July 1st, of Engineer Rear-Admiral H. H. Perring, C.B., who had been a director of J. Samuel White and Co., Ltd., Cowes, Isle of Wight, since September, 1938. We also regret to have to record the death of Mr. Albert Weddell, which occurred suddenly on June 28th. Mr. Weddell was chairman of W. G. Allen and Sons (Tipton), Ltd., Tipton, Staffs, and a few months ago retired from the office of managing director, a position which he had held for thirty-four years.

ENGINEERING STANDARDISATION.—The Minister of Supply was asked in Parliament on July 11th if, in view of the fact that Sir Ernest Lemon's committee on engineering standardisation was concerning itself with rationalisation proposals, he would so amend its terms of reference as to exclude that subject from its purview and ensure that it confined itself to its terms. In his reply, the Minister said that the committee had considered the possible effect of increasing standardisation upon the structure of the engineering industry. He was not aware, however, that it had made or was likely to make proposals for the rationalisation of the industry or any part of it.

RESISTANCE WELDING MACHINE SECTION, B.E.A.M.A.—At the recent annual general meeting of the Resistance Welding Machine Manufacturers Section of the B.E.A.M.A. the following officers were elected for the year 1949–50: chairman, Mr. R. W. Ayers (managing-director, Sciaky Electric Welding Machines, Ltd.); deputy-chairman, Mr. F. Simmons (British Federal Welder and Machine Company, Ltd.); vice-chairman, Mr. E. S. Waddington (Philips Industrial, Ltd.). Reviewing the past years' activities of the resistance welding machine industry, Mr. R. W. Ayers spoke of the expansion that had taken place in home and export sales and of the improvement in the supply of raw materials.

WATERWORKS RADIO COMMUNICATION.—Service and maintenance vans used by the County Borough of Brighton Waterworks Department have been equipped for radio communication and no longer have to return to the engineer's office for further instructions when a job has been completed. Instructions regarding further jobs, or emergencies, are sent to the employees in charge of the vehicles by radio and the elimination of unnecessary journeys thus achieved means a great saving in petrol and time. This radio service has been equipped by Marconi's Wireless Telegraph Company, Ltd. Each vehicle is fitted with a Marconi 10-W transmitter/receiver, and the headquarters apparatus is also a 10-W transmitter/receiver. This is installed at the reservoir 2 miles from the engineer's office from which it is operated by means of a remote-control unit operated over a G.P.O. telephone line.

SUPPORTS AND SPACERS FOR CONCRETE REINFORCEMENT.—The British Steel Reinforcement Company, Ltd., 20, Harcourt House, 19, Cavendish Square, London, W.1, has developed a series of pressed sheet steel supports and spacers used to position steel reinforcement correctly with relation to shuttering and known as "Besserfix" supports and spacers. The basis of the design of all types is the specially shaped slot which automatically adjusts the cover to suit different bar diameters. Thus, if ½in minimum cover is specified, the appropriate type will provide this cover for ½in bars, and all bars and fabric below this size, but will automatically increase the cover to ¾in for ¾in diameter bars and so on. The importance of this feature, it is claimed, is that it enables the engineer to obtain always the exact specified cover, and the contractor to provide this cover, without having to worry on site about varying bar diameters. "Besserfix" supports are made in a number of different types designed for use with top or bottom reinforcing steel in beams and slabs, for vertical reinforcement in walls or deep beams, for positioning cages in columns, for flat steel mats, or for positioning beam cages at the top of the beam.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

British Standards Institution

Wed., July 27th.—24, Victoria Street, Westminster, S.W.1, Annual General Meeting, 3 p.m.

Empire Mining and Metallurgical Congress

To-day, July 15th to Sat., July 23rd.—Grosvenor House, Park Lane, W.1.

Underground Mining Machinery Exhibition

To-day, July 15th to Sat., July 16th.—Earls Court, London, S.W.6.

Personal and Business

COLONEL NORMAN BERRY, A.M.I. Mech. E., has been appointed a director of Prior Stokers, Ltd.

MR. J. MCINNES SLATER has been appointed secretary of Drysdale and Co., Ltd., Yoker, Glasgow.

TUBE INVESTMENTS, Ltd., states that Mr. Eric Brotherton has been appointed joint managing director of the Hercules Cycle and Motor Company, Ltd.

REDIFFUSION, Ltd., states that it will be known in future as Redifon, Ltd. Its address is Broomhill Road, Wandsworth, S.W.18 (telephone, Vandyke 5691).

THE NORTHERN IRELAND GOVERNMENT announces the appointment of the Right Hon. Sir Roland Nugent as chairman of the Council of Scientific Research and Development.

THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH announces the appointment of Mr. W. K. Wallace, M.I.C.E., as chairman of the Building Research Board in succession to Sir George Burt, M.I.C.E.

B.S.A. TOOLS, Ltd., states that its Glasgow branch has been moved to 46, Carlton Place, Glasgow, C.5 (telephone, South 1121). The firm's distributing organisation, Burton Griffiths and Co., Ltd., has also been transferred to that address.

MR. J. WILSON ELLIOTT has been appointed to succeed Sir Philip Wigham Richardson as chairman of Swan, Hunter and Wigham Richardson, Ltd. Although Sir Philip is retiring from the chairmanship of the company, he will retain his seat on the board.

THE INSTITUTION OF ELECTRICAL ENGINEERS announces that the President of Council for next session will be Professor E. B. Moullin, M.A., Sc.D., and that the two vacancies for vice-presidents will be filled by Mr. J. Eccles, B.Sc., and Sir John Hacking.

LIEUT.-COLONEL S. J. M. AULD has retired from his position as chief technologist to Vacuum Oil Company, Ltd., but will continue with the company as a petroleum consultant. Dr. H. M. Davies, A.R.I.C., has been appointed manager of laboratories with responsibility for all technological matters.

THE MINISTRY OF TRANSPORT announces the retirement of Mr. H. E. Aldington, C.B., M.I.C.E., from the position of chief engineer (highways), which he has occupied since 1945. Mr. Aldington has been engaged in the Ministry for twenty-seven years. Mr. E. B. Hugh-Jones, M.I.C.E., has been appointed to succeed him.

VISCOUNT FALMOUTH, M.I. Mech. E., has been re-elected president of the British Internal Combustion Engine Research Association. Vice-Admiral (E.) Sir Denys C. Ford, Lieut.-General Sir Frederick Wrisberg, Dr. S. F. Dorey, Air-Commodore F. R. Banks, Sir Lynden Macassey, and Major-General E. H. Clayton have been elected vice-presidents of the Association. Mr. J. Jones, M.I. Mech. E., chief engineer of the National Gas and Oil Engine Company, Ltd., has been elected chairman of the council in succession to the late Mr. E. P. Paxman.

ELLIOTT STANDARDISED MAGNETIC AMPLIFIERS.—The production of a range of Standardised magnetic amplifiers by Elliott Brothers (London), Ltd., Century Works, Lewisham, S.E.13, is announced in the company's Publication G.068A, copies of which can be obtained free on request at the above address. In addition to data on Elliott standardised components, the publication contains a useful summary of the basic principles, characteristics, performance and applications of magnetic amplifiers generally.

Technical Reports

A Note on Crystallite Size and Intrinsic Electric Strength of Polythene. By D. W. Bird and H. Pelzer. (Ref. L/T194). The British Electrical and Allied Industries Research Association. Price 6s., postage 3d.—This report describes the continuation of the work on the optical properties and structure of high polymers described in Ref. L/T160. Specimens of the type formerly tested contained partly oriented crystallites and it was considered advisable to investigate whether this type of structure affected the electric strength. A series of measurements has accordingly been made on quenched and unquenched polythene, but no significant difference in electric strength was found.

The Power Supply of the Central European Area by H.V.D.C. Transmission. By A. Menge. Translated by Dr.-Ing. F. Busemann. The British Electrical and Allied Industries Research Association (Ref. Z/T78). Price 15s., postage 3d.—This paper appeared in E.T.Z., Vol. 69, pages 37-44 and 83-49, February-March, 1948, and is a shortened version of a paper read in Germany in 1947. It provides an historical review and comparison on economic and technical grounds of a.c. and d.c. transmission at high voltage. A full description of the Elbe-Berlin line (100MW,400kV d.c.), is included and the author envisages an extensive European network. It is suggested that a grid of this kind would provide strong ties between the German, Austrian, Swiss and Italian power systems, together with the French, Dutch and Belgian systems; interconnection would also favour the economic exploitation of Norwegian and Swedish surplus water power and of British coal.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1.

FUSION WELDED STEEL AIR RECEIVERS

No. 487 : 1949. This British Standard has been extensively revised and applies to pressures up to 500 lb per square inch; one important amendment is that the term "design pressure" is used throughout, not operative or working pressure. Design pressure is defined as the highest pressure to which any safety or relief valve is to be set to lift and it is desirable that there should be a margin between the working pressure and the lowest pressure to which the safety valve is set. Three new clauses have been added, five clauses differ substantially and four clauses have been modified by comparison with the 1939 edition. Possibly the amendment which will make the most difference both to makers and users is the series of constants affecting the thickness of the shell plate, which place a premium on heat treatment and weld tests. There are now six constants in place of two. In certain cases of reinforcement (compensation to openings) a tell-tale hole has been specified to ensure that any crack or imperfection in an inner weld does not build up pressure or cause undetected corrosion. New illustrations to the present edition include large-scale typical butt welds and butt weld with backing strip; several of the previous illustrations have been modified and the notes to the figures are more informative.

Price 3s., post free.

B.S.I. YEAR-BOOK

1949 Year-book. The Year-book of the British Standards Institution has just been published. It has a subject index and gives a synopsis of each of the 1500 British Standards now current. These standards have been prepared by representative committees of fifty-five different industries. It also includes lists of members of the General Council, the Divisional Councils and the Industry Committee of the Institution as well as other useful information about its work. Price 5s., post free.

SYNTHETIC-RESIN BONDED-PAPER SHEETS FOR USE AS ELECTRICAL INSULATION AT POWER FREQUENCIES

No. 1137 : 1949. Originally published in 1943, this British Standard has recently been revised. With a view to the reduction of testing to a minimum, the revised standard has been divided into mandatory and optional clauses, the former being limited to the tests necessary for the rejection of inferior material.

The principal alterations in this revision are as follows: Three alternative types of specimen are permitted for determination of tensile strength, and details of suitable grips for holding the specimens in the testing machine are included. An alternative type of electrode (tinfoil) is permitted for determination of power factor at 50 c/s. Tinfoil electrodes, attached to the specimen by petroleum jelly, are mandatory for power factor tests at 1000 c/s.

A separate British Standard for synthetic-resin bonded-paper material for use at high frequencies is in preparation. Price 2s. 6d.

SILVER ANODES AND SILVER SALTS FOR ELECTROPLATING

No. 1561 : 1949. As in the former standards of this series, details of the composition and maximum limits for insoluble matter are provided. Methods for determining the percentage of silver present and the quantity of insoluble matter are included. Price 2s.

RUST AND ACID RESISTING STEEL WIRE

No. 1554 : 1949. This standard is an extension of, and should be regarded as a companion to B.S. 970, to provide more fully for rust, acid and heat-resisting steels commonly supplied in the form of wire for general engineering purposes. The first section covering general clauses includes details of manufacture, methods of test and tolerances; Section 2 gives for each steel the chemical composition and mechanical properties. Price 2s.

B.O.A.C. "ARGONAUT" CLASS AIRCRAFT.—Delivery of the twenty-two Canadair aircraft, ordered by B.O.A.C. for use on its routes to the East and Far East, is now in progress. These pressurised air liners will each carry forty passengers and will be known in B.O.A.C. as the "Argonaut" class. The "Argonaut" which has a tricycle undercarriage, is powered by four Rolls-Royce "Merlin" engines. The normal cruising speed ranges are 230 to 240 m.p.h. at 10,000ft and 250 to 270 m.p.h. at 20,000ft, at an average weight of 80,200 lb. With a complement of forty passengers, crew and full cargo load the aircraft weighs over 36 tons and has a range of 2400 statute miles.

MAGNETIC SURVEYS FROM THE AIR.—Aeromagnetic Surveys, Ltd., a Canadian associate company of Hunting Aerosurveys, Ltd., has announced the completion of its first survey involving geophysical exploration with an airborne magnetometer. The airborne magnetometer is based upon principles developed during the war for the detection of submerged submarines through their effect of causing variations in the earth's magnetic field. Since changes in geological structure can cause variations of much greater magnitude, the possible use of the submarine detector for geophysical exploration was soon realised. In general, the airborne magnetometer survey, in conjunction with other geological data, indicates areas in which other more direct methods of exploration, such as diamond drilling, should be attempted.

THE RATIONAL ALLOCATION OF COAL.—The Combustion Engineering Association is organising a two-day conference on "The Rational Allocation of Coal," to be held at the Palace Hotel, Buxton, on Thursday and Friday, September 8th and 9th. On the first day the discussions will be based on papers dealing with the training of combustion engineers, and with a technical advisory service by makers of semi-industrial and industrial combustion engineering equipment. The discussions on the second day will be concerned with the rational allocation of coal. Mr. E. W. Thompson will preside over the conference, attendance at which is not to be restricted to members of the Combustion Engineering Association. Applications for membership of the conference should, be sent to the Secretary of the Association, at 24, Tottenham Court Road, London, W.1.

BUILDING LICENSING LIMITS.—The Minister of Works has made an Order (S.I., 1949, No. 1102) fixing the amount of building work which may be carried out without a licence during the twelve months July 1, 1949, to June 30, 1950. For ordinary properties, including dwelling-houses, a licence will be required for work in excess of £100 in the twelve months. For special classes of buildings, namely, industrial buildings, farm buildings other than dwelling-houses, educational buildings, office buildings with a floor area of not less than 10,000 square feet, and warehouses with a floor area of not less than 5000 square feet, the limit will be £1000. Minor amendments have been made in the definitions of the special classes of buildings with the purpose of removing certain anomalies. A completely new definition of storage buildings has been substituted so that warehouses used for the storage of goods in the course of carrying out industrial, professional and commercial undertakings now qualify for the £1000 limit, and the definitions of agricultural, educational and office buildings have also been slightly widened.

A Seven-Day Journal

New Oxford Geology and Mineralogy Laboratory

THE new building for the Department of Geology and Mineralogy at Oxford, which was opened by the Vice-Chancellor of Oxford University on Thursday, July 7th, was made possible by the gift of £25,000 by the Shell Petroleum Company, Ltd., for its construction and equipment, following an appeal in 1937 by Oxford University. The war delayed the completion of the new laboratory, which has been erected on the site of the original Clarendon Physics Laboratory built in 1860. The laboratory building is simple and dignified in its architectural style and is constructed of local limestone from Bladon with dressings of Clipsham stone. It comprises a spacious hall and well, with a gallery on the first floor, which leads to large and well-lighted students' laboratories, staff rooms and the library. The new building housed, until Wednesday last, July 20th, an "Exhibition of Oilfield Equipment," which was arranged by the British Petroleum Industry to commemorate the opening of the new building. In the hall a map of the oilfields of the world was displayed, giving the position of the oilfields in the Commonwealth and in other countries. In the ante-room were the products of British manufacturers of oil-drilling and production plants. The Commonwealth room was set apart to show the search for oil in the Commonwealth and its development. On the first floor was a Middle East Gallery dealing with the oil developments in Iran, Iraq, Egypt and Burma. An aerial photograph room illustrated the use of aerial surveys and their interpretation for topographical and geological map-making. In the technical room modern methods of subsurface correlation by means of typical rock-cores micro-palæontology and electrical and gamma-ray logging were displayed, along with maps made by the various geophysical methods such as the gravity, seismic and magneto methods now employed in the determination of underground structure. In the same room technical photographs were shown. The second floor of the new building served to accommodate a comprehensive display of mine survey and geophysical instruments and geological microscopes, arranged by a survey group of the Scientific Instrument Manufacturers' Association. In the film theatre a series of films dealing with various phases of the oil industry was shown.

Reduction in the Number of Capital Ships

IT is announced by the Admiralty that the essential need of the present time of having in commission as many as possible of the smaller vessels of the Royal Navy, has led to a review of the types of ship which are to be kept in commission. With the object of increasing the numbers of the smaller ships such as destroyers, frigates and minesweepers that can be maintained fully operational, and in view of the fact that very few large surface ships are being kept operational anywhere in the world, it has been decided to reduce the number of battleships in full sea-going condition. That decision has been put into effect as follows:—At present the Training Squadron consists of the two battleships "King George V" and "Anson" and the Fleet aircraft carrier "Victorious." This squadron, which is sea-going, would form the nucleus of a battle fleet, or task force, if required in an emergency. It is announced that H.M.S. "Vanguard" will be substituted for the "Anson" in the squadron. On returning from the Mediterranean Sea at the end of July, the "Vanguard," after some special trials, will join the Training Squadron at Portland, but she will remain available for special duties if required. On the completion of her present refit, the "Duke of York" will become the Flagship of the Flag Officer Commanding Reserve Fleet. On the completion of the refit now being carried out, the "Howe" will be placed in reserve. When relieved by the "Vanguard" in the Training Squadron the "Anson" will similarly be reduced to reserve. It is to be clearly understood, the Admiralty notice concludes, that all our capital ships, whether in reserve or otherwise, will be available for operational duty if occasion demands.

America and Information on Atomic Energy

IT is now known that the conference which was called at Blair House, the temporary residence of President Truman, on Thursday, July 14th, and was attended by members of the Administration, Congressional leaders, members of the Atomic Energy Commission and the military authorities, was to discuss the future policy of the United States with relation to co-operation with Great Britain and Canada in the atomic field. A formal statement which was issued in Washington on Tuesday, July 19th, by Senator McMahon, the chairman of the joint Senate House Atomic Energy Commission, says that after last week's meeting, which was attended by members of the joint committee, it was decided that the committee should meet in closed session on Wednesday, July 20th. At this meeting it explored with the Department of State, the National Military Establishment and the Atomic Energy Commission the continuing problem of the relations with the United Kingdom and with Canada in the field of atomic energy. It is pointed out that at the present time the three countries are co-operating in a limited number of specifically defined areas of information, as well as on matters concerning the supply of raw materials. The object of Wednesday's meeting was, it appears, to discuss with the three agencies most directly concerned the problems lying immediately ahead in the relations between America and Britain and Canada in this particular field.

Colonial Development and Welfare

A RETURN of the schemes made under the Colonial Development and Welfare Acts by the Secretary of State for the Colonies with the concurrence of the Treasury, in the period from April 1 to March 31, 1949, has been published by the Stationery Office. Particulars are given of some 430 schemes, benefiting territories in West, Central and East Africa, the Middle East and the Far East, the Mediterranean, Indian Ocean and Pacific Ocean territories, and the West Indies. These schemes total £1,652,169. With regard to Colonial Development Plans generally approved during 1948–1949, it is pointed out that the British Guiana Plan provides for a total expenditure of £6,650,000. It is emphasised that the plan is based on the development of economic services, in the belief that improved social services must be built up on a foundation of increased production and real wealth. This plan is principally concerned with the development of the coastal belt where 95 per cent of the population live. The recommendations made in the report of the British Guiana and British Honduras Settlement Commission for the development of the sparsely inhabited interior of the Colony are under consideration. The St. Lucia Plan provides for a total expenditure of £900,000. Again it is largely economic, but it covers some expenditure on the social side. The rebuilding of the town of Castries alone will require as much again as is provided in the plan. The Granada Plan provides for an overall expenditure of £1,741,060 for a revival of agriculture. The North Borneo Plan provides for a total expenditure of £5,534,159. The country has suffered severe devastation in the war, and must be restored to pre-war level and the essential services built up to an extent to open up the country for development. About a third of this amount will be spent on communications.

Canada and Agricultural Machinery

IT is announced by the Board of Trade that the United Kingdom Agricultural Engineering Mission has now returned from Canada after having travelled some 16,000 miles and meeting many farmers and others interested in agricultural machinery and farm equipment. It is further stated by the Board that the members of the Mission found that British agricultural machinery was virtually unknown in Canada. The Mission suggests that as an interim measure British manufacturers should take steps to advertise their products by means of specialised export trade journals and catalogue material of a standard at least as high as that of their North American competitors. Another problem, it is pointed out, will be the provision of a satisfactory spares service after sales have been made. At the present time a Canadian farmer using a locally made product can have spare parts flown to him in a few hours should that be necessary. The extent of the potential Canadian market is indicated by the fact that during 1948 Canada imported just under £20,000,000 value of agricultural machinery from the United States, while in the same period only £500,000 worth of farm machinery was purchased from Great Britain. The report of the Mission, which went to Canada in May at the invitation of the Canadian Federation of Agriculture and which consisted of ten representatives of leading firms, trade associations and the National Agricultural Advisory Service under the chairmanship of Captain E. N. Griffith, R.N., the President of the Agricultural Engineers' Association, will, it is expected, be ready in the autumn of this year.

Co-operation in International Engineering Science

ARRANGEMENTS for an International Conference of Engineers' Associations in 1950, to discuss improved international co-operation in the field of engineering sciences, were considered at a meeting of experts at Unesco House, Paris, from July 11th to 13th. There are already, it is pointed out, a number of permanent international associations concerned with the study of specialised subjects, as well as many national societies for different branches of engineering in various countries. International co-operation between these societies has developed, until now, in various ways: sometimes through occasional contacts, and now and again it has resulted in the creation of permanent organisations such as the World Power Conference, which called for study of problems of power as affecting various specialised engineering associations dealing with electrical, gas, chemical, civil and mechanical engineering. These relationships, however, in certain fields are practically non-existent, but occasionally they have been formed between national associations of neighbouring countries. In view of the complexity of this situation, the experts meeting at Unesco House have requested Unesco to arrange, as early as possible, an international conference on engineering science. This conference will form a consultative organisation, which will assist the co-ordination of activities of international associations specialising in different branches of engineering science. The experts also decided to form themselves into a provisional consultative committee until the conference. They elected as chairman of this committee Monsieur Eric Choisy, who was recently elected President of the Société Suisse des Ingénieurs et des Architectes. The secretarial work of the committee will be undertaken by Unesco.

Axial Flow Ducted Fan Theory

By D. B. WELBOURN, M.A.*

THE computation of an axial flow fan characteristic by hitherto published methods tends to be a laborious process. The following method is relatively quick and is found to yield results which correlate well with tests results when allowance has been made for tip clearance. The axial air velocity through the fan is assumed to be constant and the effects of compression and solidity on it are neglected.

What follows is based on static efficiency (i.e., pressure energy of air/work done by fan) and not on adiabatic efficiency, since the purchaser of a fan is usually uninterested in the energy represented by velocity given to the air. For the sake of simplicity in presentation, axial air entry is assumed and no account is taken of the possible recovery of whirl energy in a diffuser, whether fixed or

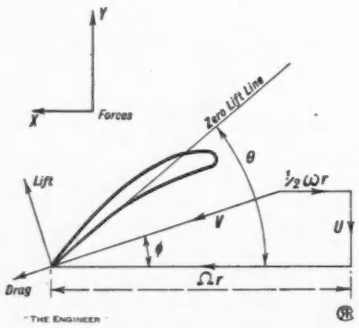


FIG. 1

contra rotating. It may be computed in a similar manner.

For any blade element at radius r, the static pressure rise is given by

$$\Delta p = \eta \,.\, \rho \,.\, \omega r \,.\, \Omega r, \quad . \quad . \quad . \quad . \quad (1)$$

where

η = static efficiency,
ρ = density of fluid,
ωr = velocity of whirl (Fig. 1),
Ωr = velocity of blade element.

Evaluation of Velocity of Whirl

Neglecting drag, if

K = circulation round a blade,
V = mean velocity of air relative to blade,
C_L = lift coefficient,
c = chord,
N = number of blades.

Then

$$\text{Lift} = \rho V K.$$

But

$$\text{Lift} = \tfrac{1}{2}\rho V^2 \,.\, c \,.\, C_L.$$

Therefore

$$K = \tfrac{1}{2} V \,.\, c \,.\, C_L.$$

But circulation in slipstream at any radius r is

$$2\pi r \,.\, \omega_1 r,$$

where

$\omega_1 r$ = velocity of whirl in slipstream due to K.

Therefore

$$K = 2\pi r \,.\, \omega_1 r \,.\, 1/N.$$

Therefore

$$2\pi r/N \,.\, \omega_1 r = \tfrac{1}{2} V \,.\, c \,.\, C_L.$$

Therefore

$$\omega_1 r = \tfrac{1}{2}\sigma \,.\, V \,.\, C_L \quad . \quad . \quad . \quad (2)$$

where

$$\sigma = \text{solidity} = N \,.\, c/2\pi r.$$

We can put

$$C_L = 2f(\alpha) \,.\, \sin(\theta - \phi).$$

* Development engineer, W. H. Allen, Sons and Co., Ltd., Bedford.

In the ideal case

$$f(\alpha) = \pi.$$

Then

$$C_L = 2f(\alpha)\,[\sin\theta\cos\phi - \cos\theta\sin\phi].$$

From (2) and substituting for $\cos\phi$ and $\sin\phi$ we obtain

$$2\omega_1 r/\sigma \,.\, V = 2f(\alpha)\ [(\Omega r - \tfrac{1}{2}\omega_1 r)/V \,.\, \sin\theta - U\cos\theta/V]$$

Therefore

$$\omega_1 r = \sigma \,.\, f(\alpha) \,.\, (\Omega r \,.\, \sin\theta - U\cos\theta)/(1 + \tfrac{1}{2}\sigma \,.\, f(\alpha) \,.\, \sin\theta) \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The value of $\omega_1 r$, as given by equation (3), makes no allowance for drag. This may be corrected by adding a term evaluated as follows, assuming that all the tangential component of drag is converted into whirl energy.

Drag $= \tfrac{1}{2}\rho V^2 \,.\, c \,.\, C_D$, where C_D = drag coefficient.

For an annulus,

$$\tfrac{1}{2}\rho V^2 \,.\, N \,.\, c \,.\, C_D \,.\, dr \,.\, \cos\phi = 2\pi r \,.\, dr \,.\, \rho \,.\, U \,.\, \omega_2 r.$$

Where

$\omega_2 r$ = velocity of whirl due to drag.

Putting

$\cos\phi = \Omega r - \tfrac{1}{2}\omega_1 r/V$, we obtain

$$\omega_2 r = \tfrac{1}{2}\sigma \,.\, C_D \sqrt{(\Omega r - \tfrac{1}{2}\omega_1 r)^2 + U^2}/U \,.\, [\Omega r - \tfrac{1}{2}\omega_1 r] \doteq \tfrac{1}{2}\sigma \,.\, C_D \,.\, 1/U \,.\, [(\Omega r - \tfrac{1}{2}\omega_1 r)^2 + \tfrac{1}{2}U^2] \quad . \quad . \quad . \quad . \quad (4)$$

Therefore total whirl velocity in slipstream is

$$\omega r = \omega_1 r + \omega_2 r \quad . \quad . \quad . \quad . \quad (5)$$

The value obtained for ωr is, of course, not exact, but for practical purposes this result is sufficiently accurate until the stalling point is reached.

Since the maximum value of ωr in normal fan designs with a high degree of reaction is

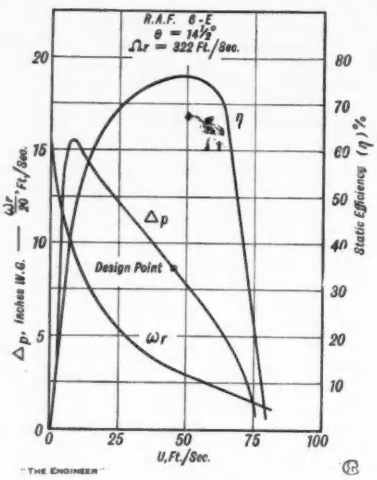


FIG. 2

$\omega r = \Omega r$, values for ωr at flows less than that obtaining at the stalling point can be obtained by using this zero-flow point and completing with a smooth curve fitted by eye, as shown in Fig. 2. They are, however, of little value for calculating the pressure-flow characteristic, since other effects tend to become of overriding importance at low flows.

Evaluation of Static Efficiency

Force acting in plane of rotation

$$= X = L\sin\phi + D\cos\phi$$

Force acting axially

$$= Y = L\cos\phi - D\sin\phi$$

Tangential force coefficient

$$= C_X = C_L\sin\phi + C_D\cos\phi$$

and axial thrust coefficient

$$= C_Y = C_L\cos\phi - C_D\sin\phi.$$

The values of C_L and C_D to be used are those corresponding to an angle $(\theta - \phi)$

where

$$\tan\phi = U/(\Omega r - \tfrac{1}{2}\omega r.)$$

Now, on an annular ring, axial thrust

$$= dT = C_Y \,.\, \tfrac{1}{2}\rho V^2 \,.\, N \,.\, c \,.\, dr$$

and torque

$$= dQ = C_X \,.\, \tfrac{1}{2}\rho V^2 \,.\, N \,.\, c \,.\, r \,.\, dr$$

Static efficiency,

$$\eta = UdT/\Omega dQ = C_Y U/C_X \Omega r \quad . \quad . \quad . \quad . \quad (6)$$

The values used for C_L and C_D in computing are those obtainable from the published curves for "RAF 6-E" aerofoil sections. At first slight objection might be taken to this on the grounds that C_L of a blade in a cascade is much reduced and that the stalling point is reached much earlier. Experience shows that the latter objection is not true for fairly high speed fans, and the suggestion has been made that this is due to the boundary layer being centrifuged away. This is known as the Betz effect. The objection with regard to the values taken

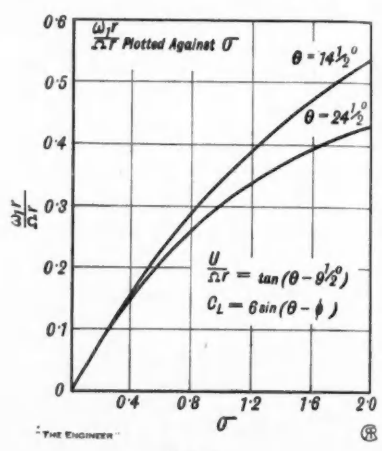


FIG. 3

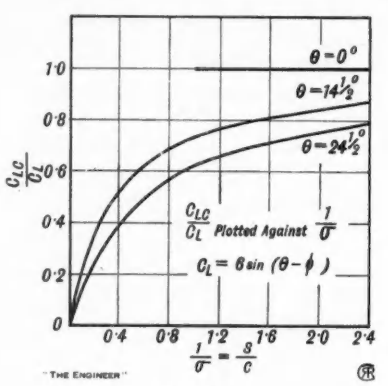


FIG. 4

for C_L is met by the nature of the expression obtained for $\omega_1 r$ in equation (3). From inspection it is clear that for $\sigma = 0$, i.e., an aerofoil on an infinite circumference, $\omega_1 r = 0$, which agrees with normal aerofoil theory.

As σ becomes large, $\omega_1 r$ tends to a limiting value, which is what might be expected for a cascade. The limiting value, however, which is obtained from equation (3), takes

no account of the geometry of the blade and thus gives results which are in general too high for blades of low camber. In Fig. 3 are plotted curves resulting from equation (3), and whereas these indicate that for $\theta = 14\frac{1}{2}$ deg. and $U/\Omega r = \tan(\theta - 9\frac{1}{2}$ deg.), the limiting value of $\omega_1 r$ for $\sigma \to \infty$ is 1·26, considerations of the geometry of "RAF 6-E" (which has a tail angle of 15 deg. and for which $C_L = 0$ when the angle of incidence $= -4\frac{1}{2}$ deg.), suggests that the limiting value of $\omega_1 r$ is in fact

$$= (\tan 17\frac{1}{2} \text{ deg.} - \tan 5 \text{ deg.})/\tan 17\frac{1}{2} \text{ deg.}$$
$$= 0{\cdot}723.$$

According to equation (3), this would occur at $\sigma = 3{\cdot}6$, and the method can therefore probably be used safely up to the largest values of σ which are likely to be used in fan design.

A point of interest is that the lift per blade is proportional to $\omega_1 r/\sigma$. In the limit, when

$$\sigma = 0, \ \omega_1 r/\sigma = f(\alpha)[\Omega r \sin\theta - U \cdot \cos\theta]$$

and therefore

$$C_{LC}/C_L = 1/(1 + \tfrac{1}{2}\sigma \cdot f(\alpha) \cdot \sin\theta).$$

If this is plotted against $1/\sigma$, curves of C_{LC}/C_L against s/c will be obtained, where C_{LC} is the effective lift coefficient of a blade in a cascade (Fig. 4). These curves afford an alternative method of assessing the effect of altering the solidity on a fan design.

The Royal Show at Shrewsbury

No. III—(*Continued from page 75, July 15th*)

WE conclude below our description of some of the many agricultural implements and machines exhibited at the Royal Agricultural Society's annual show, held at Shrewsbury from July 5th to 8th.

Ransomes, Sims and Jefferies, Ltd.

From the large number of machines displayed on the two stands occupied by Ransomes, Sims and Jefferies, Ltd., Orwell Works, Ipswich, we have selected for description the "MG.5" motor cultivator, which was added to the firm's productions earlier this year. The machine, which is illustrated by Fig. 17, may be regarded as the successor to the "MG.2," a motor cultivator which Ransomes, Sims and Jefferies, Ltd., introduced in 1936. The new machine, like its predecessor, is particularly well suited to rowcrop work as well as ploughing, cultivating and other essential tasks in market gardens and small-holdings, for which a big tractor would not be very practicable.

The chassis of the "MG.5" is of all-steel welded construction, the overall length of the machine being 6ft 2in. With the tracks in the narrow position, the width is only 3ft 2in, the overall height being 3ft 4½in, and the weight approximately 12½ cwt. The tractor is powered by a single-cylinder, four-stroke, side-valve, air-cooled, petrol engine of 600c.c. capacity and provided with dry sump mechanical lubrication, high tension impulse magneto, petrol pump and filter, air cleaner and oil filter. A self-energising automatic clutch permits easy control, and the speed, both forward and reverse, is approximately 2¼ m.p.h. The 6in tracks are of frictionless rubber-jointed construction, and the machine is supplied with the tracks set at 2ft 4½in, 2ft 7½in, or 2ft 10½in, as desired. Two drawbars are provided with the tractor, a floating one for attaching the toolbar frame direct, and the second, a swinging drawbar, for use with independent implements. The effective drawbar pull is said to be 800 lb. The machine can also be equipped with a power take-off shaft designed to work at 700 r.p.m. and transmitting 4 h.p. when on stationary work.

As stated earlier, the "MG.5" can perform a variety of tasks, and the tools designed specially for its use include a self-lift plough, a tandem disc harrow and a toolbar frame with attachments for cultivating, hoeing, ridging, furrowing and potato lifting. The tractor can also be arranged to operate a mounted spray pump.

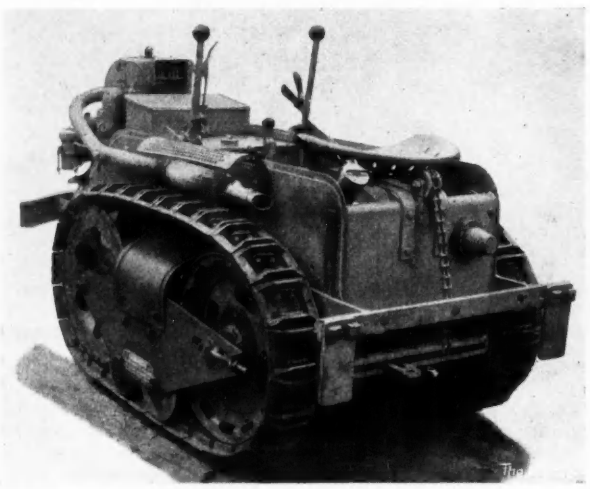


FIG. 17—MOTOR CULTIVATOR—RANSOMES

FIG. 18—SINGLE-FURROW REVERSIBLE MOUNTED PLOUGH—FORD-RANSOMES

Ford Motor Company, Ltd.

For the past three years or so the Ford Motor Company, Ltd., Dagenham, Essex, has been collaborating with Ransomes, Sims and Jefferies, Ltd., in the design and production of implements for the Fordson "Major" tractor. The latest of these implements is the reversible mounted plough, which was exhibited at the Royal Show, and an illustration of which is given in Fig. 18. Single-furrow and two-furrow models of this plough are now being manufactured.

The plough is carried on a main cylindrical steel beam, which forms the longitudinal axis of the implement, the reversing mechanism being attached to its front end. This beam runs in roller bearings, the end thrust during reversing being taken by a ball thrust bearing. The front furrow width is controlled by two adjustable set-screws, which abut against the crossshaft of the plough. Disc coulters are the standard fitting for the plough, but skim coulters can be provided for working either in conjunction with the disc coulters or as separate units. For the single-furrow implement, there is only one disc coulter, which is automatically reset for either right or left-hand work, but with the two-furrow model there is a single-disc coulter serving the front bodies, and two coulters for the rear bodies. Both models are fitted with either steel or pneumatic-tyred depth control wheels, which are actuated by means of a screw handle. The plough is attached to the tractor by the "Major" three-point linkage assembly, and is lifted and lowered by the hydraulic power lift. The only other attachment necessary to the tractor is a support bracket, fitted to the offside rear axle mounting pad, for the lever by which the reversing mechanism is operated.

The reversing action is performed manually by the use of the lever, which is on the right-hand side of the tractor driver. This lever, when pulled, disengages a pawl, which allows the plough to rotate about its longitudinal axis. A further movement of the lever will assist the plough bodies to complete their rotation until they are automatically locked in the reverse position. The reversing gear, which is simply constructed, is operated by a drive pinion and segment, the mechanism being enclosed in a detachable sheet metal dust cover.

Another attachment to the "Major" tractor, which we noted on the Ford Company's stand, is a multi-purpose transport box, which can be fitted by the three-point linkage assembly. The box, which is of sheet steel, has a capacity of 12 cubic feet, and is raised and lowered by the hydraulic power lift of the tractor.

Turner Manufacturing Company, Ltd.

The engraving, Fig. 19, illustrates a diesel-engined wheeled tractor, which has recently been put into production by Turner

Manufacturing Company, Ltd., Villiers Street, Wolverhampton, and which was shown on that company's stand at Shrewsbury. It has been designed for use with trailing implements, maximum four furrows, or with mounted implements taking a maximum of three furrows.

The tractor is powered by the makers' four-cylinder vee-form diesel engine, which is designed to develop 40 b.h.p. at 1500 r.p.m. The cylinders have a bore of 3⅜in with a stroke of 4½in, and the engine is arranged for electric starting complete with battery starter, motor and charging dynamo. The clutch is an 11in diameter single dry-plate type, which does not require internal lubrication or adjustment, and the clutch plates are removable without disturbing the engine or gearbox. The gearbox, which has also been designed by the makers, has four forward speeds and one reverse, and at the standard engine speed a tractor equipped with rubber tyres has the following maximum speeds : first, 2·2 m.p.h. ; second, 3·24 m.p.h. ; third, 4·8 m.p.h. ; fourth, 16·7 m.p.h. ; reverse, 2·48 m.p.h. The transmission is by spiral bevel differential, the final drive to the axle shaft being taken by heavy duty spur gears. The independent wheel steering brakes are of the internal expanding type and are mounted on the differential shaft.

The standard unit, as our illustration shows, is provided with rubber tyres, but steel wheels can be supplied and if required pneumatic rear wheels can be liquid ballasted. Both the front axle and the track rods are of tubular design and the steering rods are of the conventional ball type. Offset column steering is provided to give light operation and a small turning circle, but skid turns can also be made by the use of the wheel brakes. The swinging drawbar of the tractor gives lateral movement and up-and-down adjustment, and the hitch point is placed well forward of the rear axle. With the total tractor weight at 5500 lb, the makers claim a sustained drawbar pull of 4500 lb at 1·9 m.p.h. Additional equipment which can be employed includes a power takeoff with 1⅜in diameter splined shaft running at 540 r.p.m., and an 11¼in diameter pulley for belt drive, designed for a belt speed of 3000ft per minute. Another item of extra equipment is a hydraulic power lift pump, which is carried in the after portion of the " backbone " and is controlled by a selector valve under the driver's seat. The pump is driven through spur gears on the main gearbox shaft and can be disengaged through a lever mechanism. The linkage is designed to accommodate a wide range of standard mounted implements.

The Cooper-Stewart Engineering Company, Ltd.

A heavy-duty mobile sheep shearing set was exhibited on the stand of the Cooper-Stewart Engineering Company, Ltd., 57, Grosvenor Street, London, W.1. This machine, a photograph of which is reproduced in Fig. 20, consists of a removable top frame, which supports a countershaft capable of driving either independently or together as many as four shearing brackets. Power is provided by a 1½ h.p. petrol engine and is transmitted by means of a flat belt to the countershaft, the respective clutch bracket drives being vee belt operated. Incidentally, the top frame lay-out of this machine is easily removable, so that the engine mounted on its portable platform can be employed for other operations, such as driving a small chaff-cutter or a milk separator. Another sheep shearing set which attracted a good deal of attention on this firm's stand was one powered by a ½ h.p. electric motor and equipped with two shearing brackets.

There was also shown on the stand an electric cattle de-horner, for which the company was awarded a silver medal by the R.A.S.E. It is a low-voltage searing iron with thermostatic control, which can be operated either through a transformer from a mains supply or direct from a 12-volt battery.

Salopian Engineers, Ltd.

The " Sweeplift " crop collector, illustrated by the engraving, Fig. 21, is an implement which has been designed by Salopian Engineers, Ltd., Prees, Nr. Whitchurch, Shropshire, for the gathering and lifting of green grass and other similar crops. For this purpose it is drawn by the lorry into which the collected material is loaded, and in its construction the makers have not overlooked the fact that such a machine is required to operate under wet as well as dry conditions.

The three-rake bar rotating tine assembly,

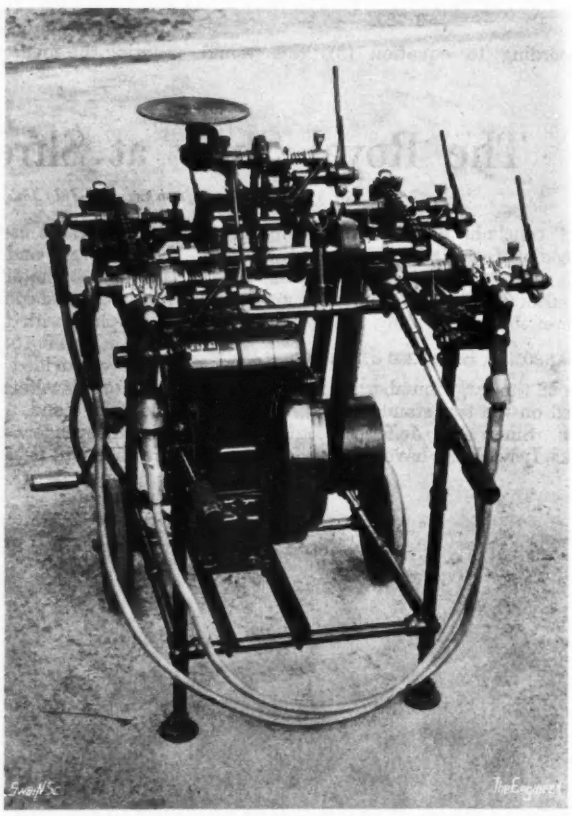


FIG. 20—PORTABLE SHEEP SHEARING SET—COOPER-STEWART

FIG. 19—40-H.P. DIESEL TRACTOR—TURNER

FIG. 21—"SWEEPLIFT" CROP COLLECTOR—SALOPIAN

shown at the front of the illustration, sweeps to a width of 6ft. It is fitted with spring tines and is timed with the crankshaft and push-bar arrangement, which, aided by a stripper device, assists smooth and even working. The elevator trough, which is of welded construction and is detachable from the chassis, is provided with a non-slipping surface. Nine push-bars, fitted with brackets and spring tines, constitute the elevating equipment, its reciprocating action being developed through a three-throw crankshaft. This elevating assembly passes the crop onto a trough delivery chute, the sturdy construction of which should be able to withstand the heaviest wet grass, and which can be conveniently adjusted by the operator on the collecting vehicle. A trough extension plate at the lower end of the machine is also adjustable for making any necessary clearance of the collecting tines. The "Sweep-lift" is mounted on two large diameter steel or pneumatic-tyred wheels, from which the main drive is taken through sprockets, chains and gears. The chains are of the precision steel roller type and have a good angle of contact round the sprockets. The castor wheels, which may be noted in the foreground of the illustration, are designed to run in the ground cleared by the sweeping tines, an arrangement which prevents them from clogging. The towbar, which has three hinge points, incorporates a universal method of attachment to the trailer, and can, incidentally, be used at either end of the machine.

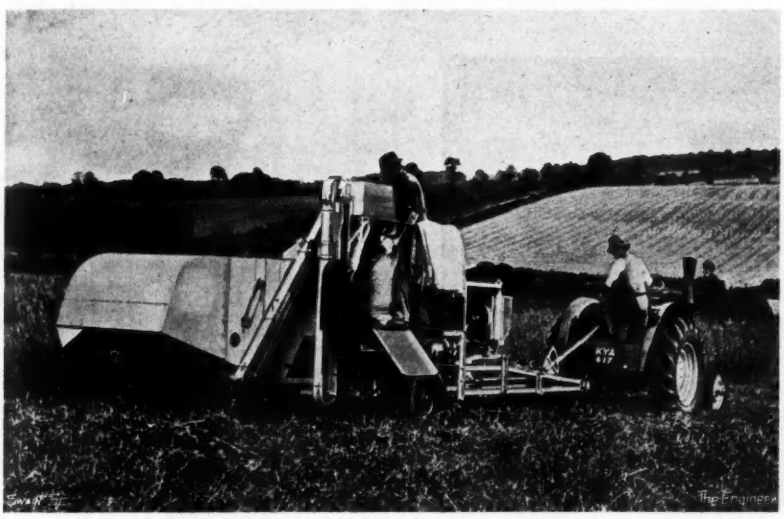


FIG. 22—"GRAIN-MARSHALL" COMBINE HARVESTER—MARSHALL

Another new implement exhibited by Salopian Engineers, Ltd., was the "Hercules" disc plough. It is convertible from five to four discs, which can be easily adjusted to give a wide range of ploughing depth and two angles of penetration. The discs are mounted to the main beam of the plough on heavy cast steel brackets incorporating housings for taper roller bearings.

MARSHALL, SONS AND CO., LTD.

One of the oldest regular exhibitors at the Royal Show is the firm of Marshall, Sons and Co., Ltd., Gainsborough, which, it may be recalled, celebrated its centenary last year. Throughout the years, this company has manufactured threshing machinery as well as a variety of other agricultural and general engineering equipment. Its long experience in the design of threshers has naturally led recently to the addition of a combine harvester to its list of present productions, and an example of this machine, which is known as the "Grain-Marshall," formed part of the firm's exhibit at Shrewsbury.

The harvester, a photograph of which is reproduced in Fig. 22, is drawn by a tractor, the cutting and threshing mechanisms being driven by a petrol engine. The main dimensions of the model illustrated are 22ft long and 9ft 6in wide, and the width of its cut is 5ft 9in. The main frame of the harvester is constructed of strong section angles and sheet steel panels, and the pneumatic-tyred wheels are mounted on roller bearings. A six-bladed reaper reel is driven from the land wheel of the harvester, and the knife bar is arranged to provide for a cutting range of from 2in to 20in from the ground. The knife itself works on a simple oscillating principle, the hub driving the oscillating shaft running on a grease-sealed ball bearing. The cut corn falls on to a travelling canvas pitched at a convenient slope for delivery to the threshing drum, and an auxiliary top feed canvas, placed at the top of the main feeder canvas, helps to ensure a more even delivery of the crop. The threshing drum itself is of the ribbed six-beater pattern similar to that used for the firm's standard threshers, the beater and bar type concave, fixed on a perforated plate, being adjustable independently at either end. The threshing drum is 5ft in length and has a diameter of 15in. A large diameter straw beater, fitted at the rear of the drum, pulls the straw over a perforated concave plate in order to obtain a further separation of grain from the ear. The dressing shoe contains a separating grid and a cavings riddle and grid, and a blower directs a blast to both riddle and grids, adjustable plates being provided on each side of the blower for wind regulation. A tailings return elevator returns any grain or ears which may pass over the cavings riddle, and, finally, the threshed grain is elevated to a small container through which it is ejected to the bagging spout.

The thresher drive is taken from the engine through a totally enclosed clutch and bevel gearbox, the bevel gears running in an oil bath. From the gearbox there is a chain drive to the remaining mechanisms. Safety clutches are provided where necessary on the threshing mechanism to prevent damage in the event of choking, and the engine clutch can be disengaged by a hand lever operated from the ground. The threshing drum, the makers say, normally runs at 1580 r.p.m. when the governed speed of the engine is 2000 r.p.m. The maximum land speed of the "Grain Marshall" when harvesting is three miles per hour.

The Institution of Naval Architects: Summer Meeting

No. III—(*Continued from page 65, July 15th*)

VISITS AND EXCURSIONS

During the afternoon of Tuesday, June 28th, two visits to works and shipyards were arranged. One party visited the Rosebank works of Brown Bros. and Co., Ltd., where hydraulic work connected with steering gears and Denny-Brown stabilising equipment for ships was going through the shops. The party also saw the wave-making machinery installed by Brown Bros. at the Portobello Swimming Baths.

At the Victoria shipyards of Henry Robb, Ltd., West Pier, Leith, another party inspected the shipyard ship-repairing department and engineering works. Several interesting ships for New Zealand and the British India Steam Navigation Company, Ltd., and dredgers for New Zealand and the Manchester Ship Canal Company were seen under construction. Interest was shown in the template method used in the yard. Another Tuesday afternoon event was a coach excursion to Abbotsford, Melrose Abbey and Dryborough Abbey.

During the meeting at the Royal Society of Edinburgh on Wednesday morning, June 29th, the ladies of the party were shown the City of Edinburgh and its surroundings.

In the afternoon of Wednesday, the whole party was received at the City Chambers by Baillie Stewart Lamb, who deputised for the Lord Provost of Edinburgh.

Friday, June 30th, was a whole-day visit to Dundee, where the well laid out and equipped shipyard of the Caledon Shipbuilding and Engineering Company was inspected. An excellent luncheon was served at the shipyard, which was reached by a special train from Waverley Station, Edinburgh. The party was warmly welcomed by Mr. Edgar P. Brown, the chairman of the company, and by Mr. George C. Parker, the managing director, and his technical staff. The shipyard was full, every berth being occupied and two ships were being fitted out. The arrangements made for the prefabrication of structural parts and the use of welding and gas cutting machines were noted. Interesting ships included those under construction for Watts, Watts and Co., Ltd., and the North of Scotland and Orkney and Shetland Steam Navigation Company, Ltd. Besides the various departments of the shipyard, the boiler works and the joiners' shop were inspected, and some specimen cabins for the ships above referred to were seen. A noteworthy feature was the greatly improved crew accommodation in these vessels. On leaving the shipyard, the party was shown some of the many light industries which have been established, and have led to the laying-out of an industrial estate with housing accommodation on the high ground above the City. The hope is expressed that these new industries will help to balance out the staple industries of jute flax, engineering and shipbuilding.

Before leaving Dundee, the party was received at the City Chambers by the Lord Provost, and tea was given. The Edinburgh Summer Meeting of 1949 will long be remembered by those who were privileged to attend.

The Underground Mining Machinery Exhibition

No. III—(*Continued from page 63, July 15th*)

In this article we conclude our account of some of the exhibits at the Underground Mining Machinery Exhibition, which was held at Earls Court from July 7th to 16th.

Some Other Exhibitors

Coal conveying plant was a prominent feature at Earls Court, and in addition to that made by the firms dealt with individually in the foregoing articles on the exhibition, a number of other well-known makers displayed a comprehensive range of this class of equipment.

On the stand of Richard Sutcliffe, Ltd., Horbury, Wakefield, the driving heads ranging from 15 to 200 h.p. exhibited included two which were being shown for the first time—the 200 h.p. "Monarch" and the 80 h.p. "Goliath."

All the driving heads were shown in motion and the "Goliath" driving head was shown complete with delivery jib, loop take-up, sections of framework and a low type tail end fitted with impact idlers, to form a complete conveyor unit. Framework of the firm's manufacture on view included the high type, which is designed to carry materials inbye and coal outbye simultaneously.

Tail ends peculiar to the various types of framework were coupled up to the respective sections. An intermediate loading section fitted with impact idlers and a stage loader completed the actual full-sized exhibits, but a working scale model of a "Little David" 15 h.p. face conveyor was also on view.

The "A.-B. Meco Moore" cutter loader, made by Anderson Boyes, Ltd., and the Mining Engineering Company, Ltd., of Worcester, has already been referred to but the latter company was also showing an extensive range of its conveying plant. The belt conveyor driving units on view ranged from a "Low Seam" 15 h.p. face-head only 15in high to the belt, up to a 75 h.p. drive employing two 30in dia. driving drums, illustrated in Fig. 33. New designs shown publicly for the first time included a 15 h.p. and a 25 h.p. face belt driving head combining compactness with accessibility and simplified assembly features.

A new type of gate conveyor structure introduced has particular advantages in transportability, ease of assembly and robustness. In face conveyor structures the most recent type of top-loading conveyor to work in conjunction with the "A.B. Meco-Moore Cutter Loader" was shown, as well as a development of the well-known "Meco" troughed face conveyor to make it suitable for thin seam applications.

Other equipment demonstrated on the firm's stand included electric and compressed air shaker engines together with a new type of ball-frame shaker troughing; troughed idlers and rollers suitable for belting from 14in to 48in wide; a compressed air turbine, and a scraper feeder for gate conveyors with modifications including a traction-type fluid coupling.

In addition to examples of its compressed air and electric motor driven jigger conveyors the Uskside Engineering Company, Ltd., of Newport, Mon., exhibited a 30in gate belt conveyor and a 20in face belt conveyor, arranged for electric drive.

The 30in gate belt is fitted with a jib extension and at the tail end with a telescopic trough giving 6ft of adjustment when extended. A loop take-up for this unit gives 50ft of belt adjustment through a belt-adjusting drum mounted on a carriage moved by means of a wire rope.

A top belt loading trunk conveyor on the stand of Hugh Wood and Co., Ltd., of Gateshead-on-Tyne, is built to take a 36in or 42in wide belt and is capable of transmitting from 100 h.p. to 230 h.p., depending on the belt speed. Power for the 42in diameter drums for driving the belt is transmitted through a totally-enclosed steel gearbox, the driving motor being mounted outboard or inboard, as required.

The intermediate sections used in conjunction with the drive head are of the maker's heavy fully troughed type, supplied in 13ft 6in lengths, and having 6in diameter oil-filled rollers for supporting the carrying and return belts.

Another drive unit designed to transmit 60 h.p. accommodates 36in or 42in belt, and is used for heavy gate or for trunk duty. The intermediate sections used in conjunction with this drive head are 9ft long and have fully troughed 4in diameter carrying rollers and 3in diameter return rollers. Drive to the 27in diameter tandem drums of this head from the electric or compressed air motor is through a worm reduction gearbox and totally-enclosed spur gears, which operate in an oil bath.

Among the scraper chain conveyors on the Hugh Wood stand was the firm's "P.F." type, which is designed for facework in room and stall or shortwall faces and can also be used as a gathering conveyor for rapid extension up to 60 yards long when driving headings. The drive head has a 5 to 10 h.p. motor, which transmits power to the conveyor through a worm reduction gearbox and then a roller chain to the headshaft. The intermediate sections are of one-piece construction, 17in wide, in 5ft lengths to correspond with the lengths of the conveying chain. The roller-borne double conveying chain has a 2in pitch and scrapers are fitted every 20in along its length.

Electric and compressed air-operated drills of various types and capacities were also shown by Hugh Wood and Co., Ltd., together with a mechanical feed device, bits, plugs, sockets, couplers, and other electrical accessories.

In addition to the manufacturers of tools such as picks, drills, &c., already mentioned in these articles on the exhibition, a variety of this type of equipment was shown by other makers.

The representative types of pneumatic picks on the stand of Dollery and Palmer (Pneumatic Tools), Ltd., 38, Victoria Street, London, S.W.1, included a tool into which a water-spraying device is built as an integral part and not as an attachment. This pick—see Fig. 34—is made with a cone at the forward end of its nose cap and a spray of water projected from the cone is designed to surround the pick-point with a mist about

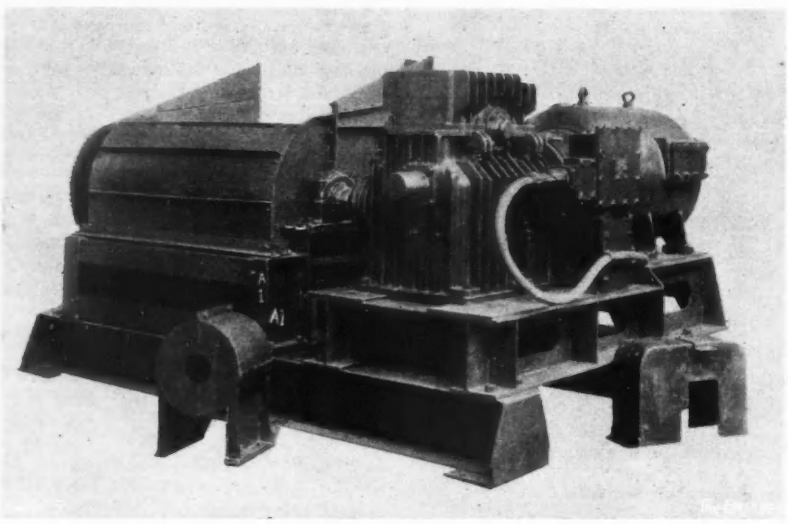


Fig. 33—Trunk Conveyor Driving Unit—Meco

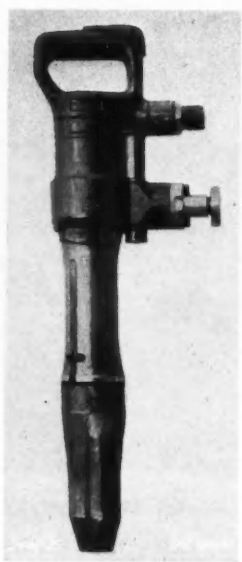


Fig. 34—Wet Pick—Dollery

12in in diameter and prevent the circulation of dust. With this tool water admitted to the nose-cap in controlled quantity through a special duct in the body of the pick, is atomised by the compressed air and ejected from the cap as a fine mist. It is claimed that a satisfactory spray is produced whatever pressure of water is available without the efficiency being affected. The air and water supply valves in the pick are coupled together and a water control valve is incorporated so that the volume of spray can be adjusted according to the water pressure available.

A special display was arranged by the Consolidated Pneumatic Tool Company, Ltd., 232, Dawes Road, London, S.W.6, to show the development of that company's wet drilling machines. In this display was shown how water under pressure is fed into the machines and applied for dust suppression. The tools comprised a pneumatic coal drill, rock drill, stone and coal drill, and the recently introduced wet coal pick. This new pick produces a finely-atomised spray over the working surface, giving a "tent" of mist. An electric coal drill was also fitted with a special water attachment.

This firm also displayed amongst its coal drills a pneumatic drill weighing only 24 lb and an electric drill weighing 27 lb, which develops 1¾ h.p.

A radially operating, column-mounted electric coal-cutter among the equipment on the stand of Siskol Machines, Ltd., of Sheffield, has been designed for narrow development work or for room and pillar mining. This machine has a 5 h.p. flameproof motor and can make a horizontal cut at any height from floor level, the rate of cutting being stated to average 1 square foot per minute. It is mounted on wheels for moving from place to place in the mine track.

As an accessory to the coal-cutters it makes this firm also builds a flexible shaft drilling attachment. The attachment consists of a flexible drive from the coal-cutter motor and a circular drill-head, in which is housed reduction gearing interposed between the flexible driving shaft and the drill-chuck spindle.

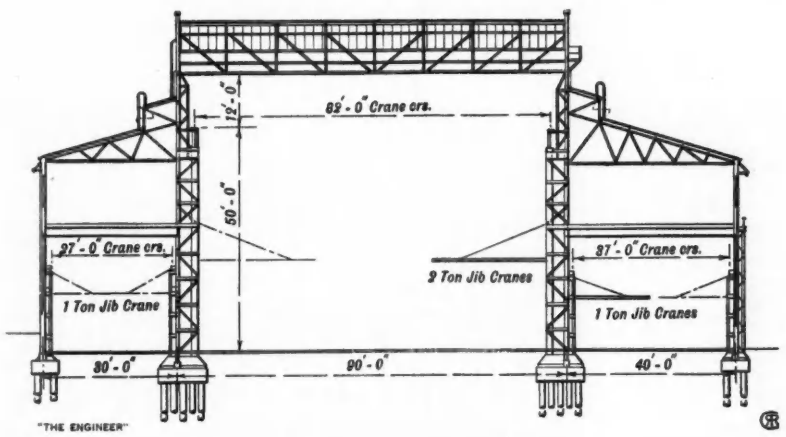
Extensions to the B.T.H. Works, Rugby

WITH the ever-growing demand for heavy plant, such as hydro-electric generators and other rotating electrical machinery, as well as power transformers, the manufacturing areas at the Rugby Works of the British Thomson-Houston Company, Ltd., have had to be increased in capacity.

The company is now completing a large new factory having a floor area of some 121,600 square feet, and equipped with the most modern plant for the manufacture and testing of the largest type of electrical plant which will be required in the foreseeable future. We were recently given an opportunity to inspect the new building, which, as can be seen in the photographs we reproduce, is in an advanced stage of construction. It is a steel-framed structure with a main bay having smaller bays with galleries above forming annexes along the full length of the building. The stanchions are spaced 25ft apart and the total length of the building is 500ft. The main central bay is 90ft wide and the annexe bays 40ft and 30ft wide respectively. There is a clear height of 62ft to the roof trusses and 50ft to the overhead crane rail tracks.

The new building has been erected on the site of an old sewage farm, and the ground conditions made extensive preparation work necessary for both the main structure and the heavy plant which is to be installed; the footings for the stanchions of the main structures have been built on clusters of reinforced concrete piles driven to depths up to 28ft.

Eight bays of the main floor area have been covered with a concrete mat some 2ft 6in in depth, and on the greater part of this area tee-slotted cast iron floor plates and rail sections have been grouted into the floor. This area, which will be used for the machining, erection and testing of heavy plant, is designed to take a loading of some 2 tons per square foot. The rails are laid on one side of the plated area and adjoin a plinth, 112ft 6in long and 8ft 3in high, provided for machine testing purposes.



CROSS SECTION OF NEW BUILDING

To facilitate the laying and alignment of the floor plates and rails an interesting technique was developed which can be followed by referring to the small drawing we reproduce overleaf. The plates and rails are held down by 1¼in bolts let into the floor structure. Each of the bolts consists of a rod screwed and welded into an 8in square, 1¼in thick plate and having a ¼in deep, 3in diameter cap welded on to the lower part of its shank. Prior to the laying of the main mass of concrete forming the floor, a 3in blinding of concrete was laid over the area, and on this the bolts were set at the correct spacing. Over the plate of each bolt there was then placed a 10in square inverted tray 2½in deep, the bolt and cap passing through a 3½in diameter hole with up-turned edges in the centre of the tray. When the bolt stood on the blinding its cap sealed the hole in the tray. On top of each tray was then welded a 4½in diameter tube of expanded metal which extended up to the sub-floor level, and this tube was covered on the outside with kraft paper. Concrete was placed round the trays to keep the bolts in position whilst the reinforcing bars were laid, and when this had been done the sub-floor concrete was poured and levelled with the bolt heads projecting above the surface.

When the floor plates were laid it was possible to move the bolts within the expanded metal tubes to compensate for any incorrect pitching or any errors in the holes in the plates. During the grouting of the floor plates after they had been bolted in position, the space between the expanded metal tubes and the bolts became filled with concrete. In the foreground of one of the photographs we reproduce can be seen a section of the floor with the bolts in position, whilst at the back can be seen the reinforcement round the encased bolts prior to the concrete being placed. Over the heavy erection area alone there have been laid seventy-eight plates each weighing 4 tons, ninety rails each weighing 1 ton, and ten rails of 15 cwt each. The rails adjoining the test plinth are designed to take an upwards pull of 90 tons, or a downwards thrust of 200 tons from machines undergoing tests.

In order to drain off any water which may get into them, the slots in the rails and the plates are connected by pipes sunk into the floor and leading out through gulleys and non-return valves to the main outlet drain of the building. The gulleys are covered by chequer plates and are readily accessible.

Plant Foundations

Some 150 tons of reinforcing steel and 7500 tons of concrete have been used in preparing foundations for special equipment and heavy machines, and for the heavy erection floor.

On the centre line of the floor-plate area two pits have been constructed for the erection and testing of large vertical water-wheel alternators. These pits, which are 8ft 3in deep, are spaced 50ft apart and are connected by a tunnel which is entered through a shaft midway between the pits. Each pit has a working area 7ft long by 8ft 6in wide, which, at a height of 5ft 6in, opens out to an aperture 12ft long by 7ft wide. When the pits are not in use they are sealed by concrete plugs having floor plates embedded in their top surface. The floors of the pits are covered by slotted plates and are designed to take a distributed load of 600 tons. In building the foundations of the pits, some 40 tons of reinforcement and 1800 tons of concrete were used. We reproduce a photograph of the pits with the reinforcement in position prior to the placing of the concrete.

The work involved in preparing machine tool foundations can be appreciated from the fact that for a centre lathe with 7ft swing by 30ft between centres and a bed 49ft long, some 7 tons of reinforcement and 155 tons of concrete have been required. An interesting feature in this particular foundation is the provision of two special chutes for the removal of chips and coolant. These chutes are made of fabricated sheet metal and lead to two pits at the back of the main foundation block. The chutes were set in position with the reinforcement, and, when the concrete was poured, became an integral part of the foundations. The chutes for swarf and chips lead down into hoppers situated in the pits, and these hoppers, when full, can be easily removed and emptied. The coolant drains into the bottom of the tanks and is circulated to the machine by pumps. This arrangement to keep the area round the machine clear of chips and coolant has been introduced as a result of the success of similar arrangements in other parts of the works. In the general view showing the main lay-out of the building the lathe foundations prior to placing of the main block can be seen in the lower left-hand corner.

Among the other heavy machine tools to be installed in the building will be an 800-ton consolidating press for field coils, a 400-ton pole press, a boring mill with a 25ft table and a

special superstructure, a 24ft by 12ft planing machine, a 30ft by 10ft wall planer, a 9ft travelling radial drilling machine, and a 15ft swing by 26ft between centres banding and commutator skimming lathe. Most of these machines will be held down by foundation bolts of a similar design to those used for the floor plates.

Annexes and Galleries

The annexe along each side of the main building is used for the manufacture of detail parts, and also provides accommodation for the testing equipment, engineering and drawing-offices, lavatories, lifts and stairs, stores, &c.

The annexe on the east side of the building is some 40ft wide, and has a ground floor with a height to the gallery above of 28ft 6in. The gallery has a height to the roof of 14ft. Outside this annexe is a sub-station containing a 600-kW motor converter set, and the high-tension and low-tension switchgear equipment for factory supplies.

The southern end of the ground floor of this annexe is to be used for the construction of the larger transformer windings, and the gallery above for transformer insulation work. For winding treatment, two vacuum vessels, one 13ft diameter by 13ft 6in deep, and the other, 10ft diameter by 12ft deep, will be erected in a pit in the annexe. Complete transformers will be vacuum baked and filled with oil in a vacuum vessel, 35ft long by 20ft wide by 19ft deep, situated in the main bay.

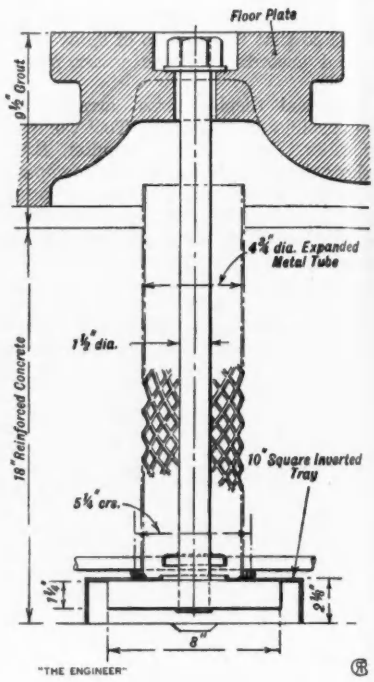
In the northern end of the annexe, adjacent to the large transformer assembly and testing area, will be housed the main testing machines. The test control apparatus and switchgear will be situated in the gallery above, erected on an auxiliary floor some 5ft above the main gallery floor, the intervening space accommodating the cables connecting the control equipment and test machines. Where these cables pass down to the ground floor, they will be carried on frames built into the east wall of the annexe. Cables leading out to various parts of the building for coupling to plant on test will be carried in a duct on the edge of the gallery, and down the main stanchions way to the test stations. A 2-MV impulse generator and a uniform field gap voltage divider are to be installed on the main floor at the north end of the building adjacent to the transformer test area.

The annexe on the west side of the building is some 30ft wide and has a gallery at the same height as that of the east annexe. A mezzanine floor, 175ft long has been built at the north end of this annexe. On the ground floor at the south end a number of production machine tools and special equipment are to be installed; the remainder of the area will be used for stores and packing. The gallery up to the mezzanine floor wall will be used for the manufacture and impregnation of generator windings. The mezzanine floor has been arranged for offices for the transformer engineers and the floor above has been equipped as a transformer drawing-office.

General Equipment and Services

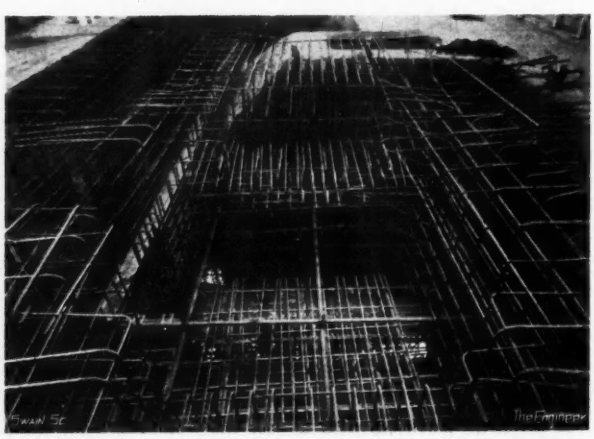
The new building is particularly well supplied with lifting equipment. Two overhead travelling cranes, each of 110 tons' capacity, with a 50ft lift, serve practically the whole length of the main floor. These cranes can be coupled together with a lifting beam, and used to raise loads up to 200 tons to a height of 40ft. Each of these cranes is also fitted with a 50-ton capacity auxiliary hoist and a 5-ton whip hoist. For lighter work a 50-ton overhead travelling crane, with a 25-ton auxiliary hook and a lift of 50ft above floor level, is installed. The 50-ton hook can be lowered 10ft below floor level to simplify erection work in the test pits. It is interesting to note that to facilitate the installation of the travelling cranes, and for maintenance work in the future, central stanchions of the building and the connecting roof girders have been specially strengthened. An auxiliary block and tackle can be attached to a beam

HEAVY PLANT BUILDING



FLOOR BOLT ASSEMBLY

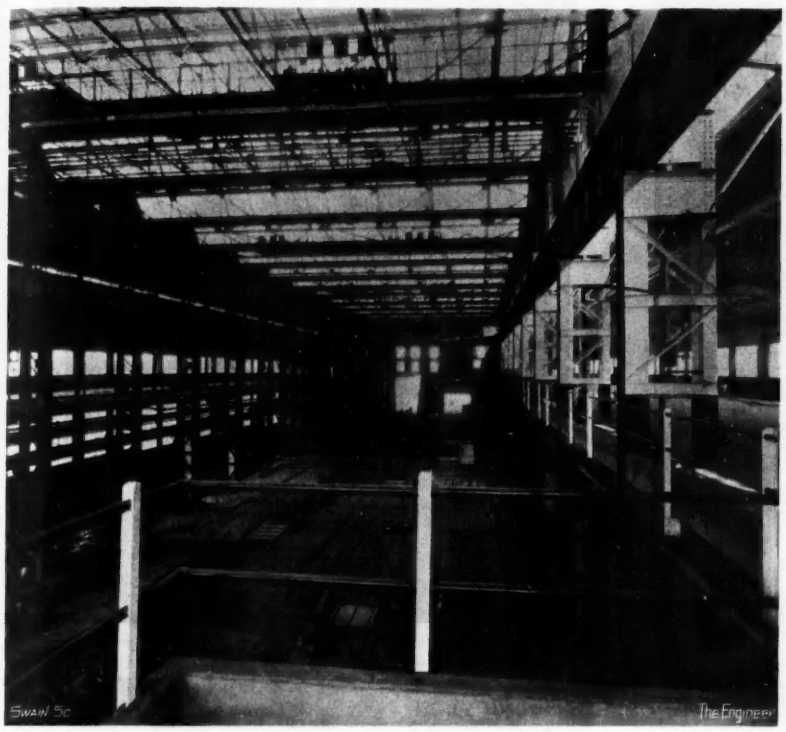
FLOOR BOLTS AND REINFORCEMENT



TEST PIT REINFORCEMENT

across these two girders to enable the heaviest parts of the cranes to be lifted into position.

The south section of the west annexe is served by a 12-ton overhead travelling crane with a 6-ton auxiliary hoist. The east annexe has a similar 12-ton crane at the south end, and also a 35-ton travelling crane over the test machine room. Each stanchion in the main bay has been designed to carry a 2-ton jib crane with a 30ft radius, and the annexe stanchions will each carry a 2-ton jib crane with a 17ft 6in radius. Four 2-ton lifts have been installed for transporting goods up to the galleries. One lift is at the south end and one in the middle of each annexe.



MAIN BAY OF NEW BUILDING

Excellent natural lighting is provided throughout the building by the north light roof, large windows in the wall panels and glazed jack roofs on the galleries. For the general lighting of the main bay by artificial means, special lighting galleries have been built in each third bay. Set into the floor at two points in these galleries is a Mazda 2½-kW high-pressure mercury-vapour lamp arranged between two Mazda 1½-kW tungsten lamps. These lamps provide a general illumination of 17 foot-candles over the whole floor area. A staircase at the south end, from the east gallery, and a walkway on the outside on the main structure over the east annexe roof provide easy access to the galleries for maintenance of lights and building roofs.

Service points for the supply of electric power, water, steam, compressed air, gas, drainage, hydraulic power, &c., are well distributed throughout the building, and all the mains are supported on the stanchions below gallery floor level.

When the new building was being designed provision was made for a future extension which will double its length, and for this reason the south end gable wall has been formed of steel sheeting, which can be readily removed when required. Space outside the north end of the building is available for the erection, at some future date, of a building to house the high-voltage testing plant, which, for the time being, will be situated in the north end of the main bay.

Protective Equipment for Handling Radium Sources

FOR many years Johnson Matthey and Co., Ltd., 73–83, Hatton Garden, London, E.C.1, has maintained a laboratory specially equipped and staffed to carry out research into industrial methods for handling and using radiographic materials. Particular attention has been devoted to the question of safety and to devising ways of minimising the amount of radiation to which an operator can be exposed. Through experience gained in this work a number of special items of equipment have been developed for storing, handling and using radium sources.

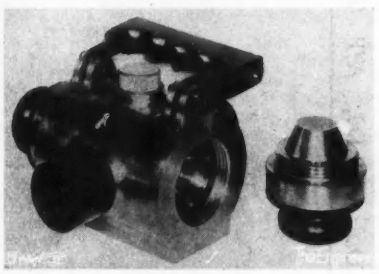


FIG. 1—PORTABLE CARRIER AND STORAGE UNIT

To-day gamma radiography is firmly established industrially as a method of non-destructive testing and inspection, and the use of this technique is likely to become more widespread now that suitable radium or radon sources are obtainable from the Government-owned Radiochemical Centre at Amersham. Accordingly, Johnson Matthey and Co., Ltd., has arranged for various items of special equipment evolved by the company to be produced commercially. Some of these equipments are described and illustrated herewith.

THE PORTABLE CARRIER

The bulk of industrial radiography is carried out by means of 100mg to 250mg radium sources, whose use demands every possible precaution. Satisfactory results may sometimes be obtained from sources as small as 15mg to 30mg, but these can obviously handle only a limited range of inspection work.

To house the larger and more commonly

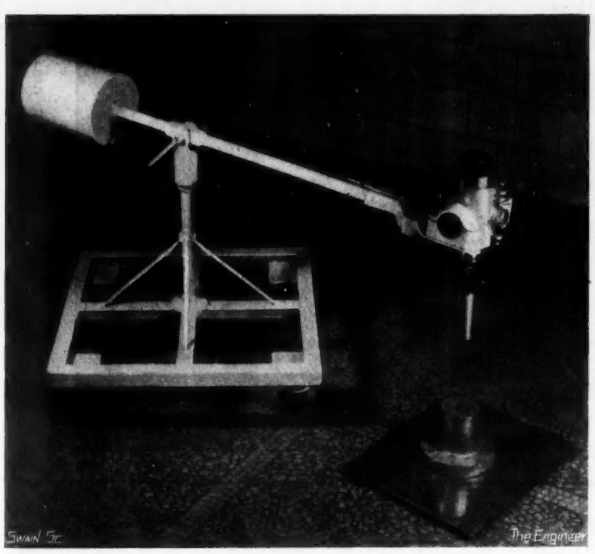


FIG. 2.—MOBILE EXPOSURE STAND

FIG. 3—TIME-CONTROLLED EXPOSURE UNIT

IZAL FACTORY OF NEWTON CHAMBERS AND CO., LTD., AT THORNCLIFFE

CONSTRUCTION OF CANOPIES AND BRIDGE

SEMI-PORTAL FRAME CONSTRUCTION

LOADING DOCK

BOTTLING AND PACKING ROOM

used sources of 100mg to 250mg a standard portable carrier (Fig. 1) has been devised to serve for storage as well as transport of the radium. It weighs only 38 lb and can thus be handled with ease by one man. Very good protection is stated to be given by this equipment, the radiation being less than 0·2 röntgen per day—well below the accepted tolerance dose—at a distance of 3ft from a carrier containing a 250mg source. This carrier can also be used to house radon or other gamma-ray sources up to a value of 250 millicuries.

The carrier is machined from a phosphor-bronze casting and incorporates a thick liner of copper-tungsten Elkonite, which has a very high coefficient of absorption of radiation. The radium source, in a platinum container, is held at the centre of the carrier by a clip mounted upon an Elkonite rod. Extraction of the radium is easily achieved by means of a handling extension which, after removing the knurled cap at the top of the carrier, can be screwed into the rod bearing the source. Two heavy conical plugs are fitted in the ends of the carrier, which are so designed that the operator's hand is not exposed to direct radiation while they are being removed or replaced.

In making single exposures the portable carrier can be mounted upon a mobile stand, shown in Fig. 2. The design of the carrier is such that upon the removal of one of the conical end plugs a uni-directional radiation beam of fairly narrow angle is released. Accurate "sighting" of the object to be radiographed is carried out with the help of a prismatic "viewfinder." This accessory is shown in Fig. 2 screwed into the lower end plug ready for sighting the object. After the sighting device has been used to bring radium source, carrier orifice and object exactly into line, the conical plug is removed and the exposure made.

Time-Controlled Exposure Unit

Panoramic exposures, involving the simultaneous radiography of forty or more castings are made by combining the portable carrier with a time-controlled exposure unit (Fig. 3). This unit is essentially a small motor-driven lifting device which may be pre-set to operate after any desired time interval up to seven days and to make an exposure of predetermined duration. The operating rod of the unit is screwed into the rod which supports the source, and at the chosen time lifts the radium from the carrier to a height of roughly 7½in from the floor, as shown in Fig. 3. When exposure is complete the source is automatically returned to its carrier. By use of this unit it is simple to ensure that operators are at no time subject to harmful radiation. Exposures can be timed to take place in a cleared room at any convenient time of the day or during the night. A push-button switch for manual operation of the unit is fitted, and in addition there is a warning lamp which operates only when the source is exposed. Sockets are provided to allow the extension of the lamp circuit, whereby a remote warning system can easily be arranged.

The New Izal Factory

IN our issue of June 3rd we made reference to the Exhibition arranged by Newton Chambers and Co., Ltd., at its Thorncliffe works, which was held in the new Izal factory. We are now able to give a further account of this interesting new factory.

All the buildings are of reinforced concrete design. The last extension to be carried out prior to the war was of symmetrical portal frame construction, and will be seen to the left the view below. The decision to extend the Izal factory after the war, again in reinforced concrete construction, was welcomed by the government authorities concerned, as the minimum of steel was thus required, and the need for bricks, which were then in short supply, was almost entirely eliminated.

As our engravings show, the site of the factory lies on a sloping hillside, into which a large terrace has been cut at a suitable level, for sidings to be connected to the existing works railway system, in order to serve the loading docks which run the full length of each side of the buildings. One of these loading docks, protected by a reinforced concrete canopy, is shown on the opposite page. Another view shows the constructional detail of the top of the canopy, which is cantilevered from the main building and carries bays of patent glazing, giving good overhead lighting. On account of the slope of the natural ground it was found not possible to form the large basement in the new factory, which was required for the Izal storage tanks, and the heating installation underneath the railway lines. This basement was, therefore, constructed in the form of a reinforced concrete viaduct walled in between the piers supporting the railway track. The viaduct will be clearly seen in the illustration below between the new and the old factory buildings.

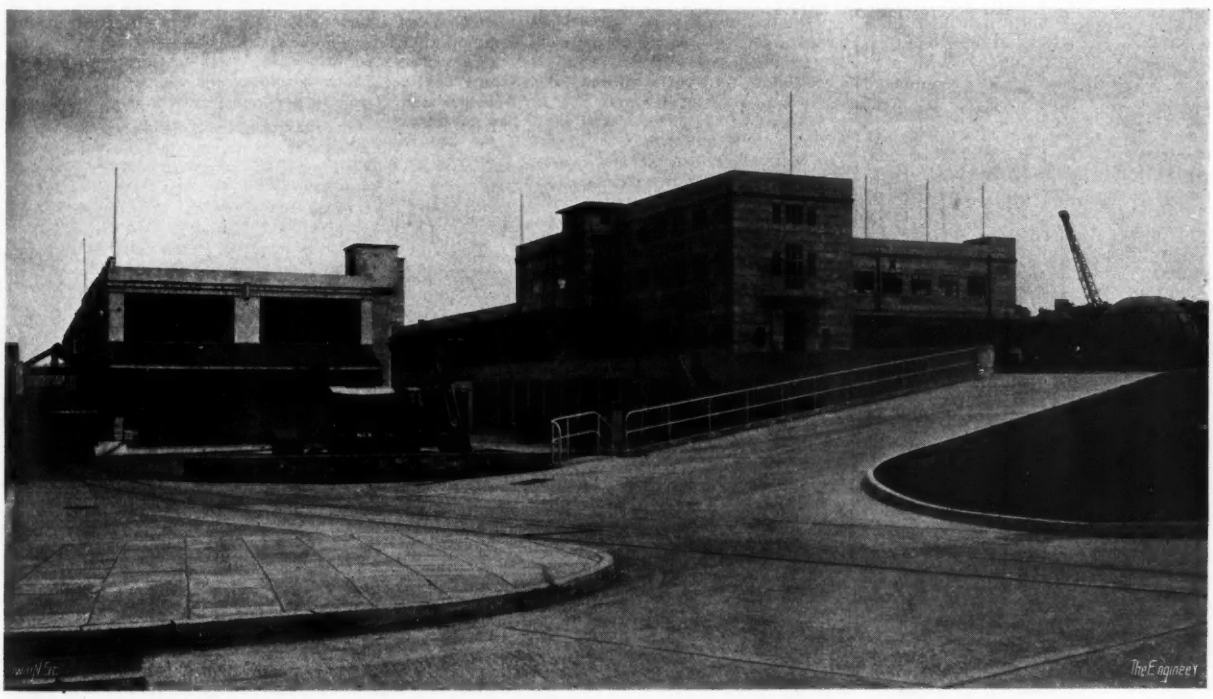
In designing the main part of the building, special care was taken to ensure that any internal walls required had no structural significance. The walls at present dividing the different departments of the factory can be taken out and re-arranged, without affecting the strength of the structure as a whole. Although the plan area of the ground floor of the new factory is 215ft by 160ft, there are only eight internal columns supporting the upper storey. These columns surround the central well, which is roofed over to form a lecture hall, to be used in connection with the firm's training and educational schemes.

The building is throughout constructed of true reinforced concrete. There are no steel girders or stanchions, and all the outer walls are of concrete. A standardised system of semi-portal or L-frames was designed, spanning from the outer walls to the beams surrounding the central well. This system is clearly shown opposite. The frames are a little more than 50ft in span, and they are designed to support an upper floor, with a loading of 150 lb per square foot, over the whole area of the building. As may be gathered from the general view reproduced below, at present only one section of the upper floor at the north end of the building has been completed.

In addition to the main factory building, which is used for the bottling and packing of the various Izal products, there is a large canteen and canteen kitchen, with a staff dining room, and the large lecture hall previously referred to. For administration purposes there is a three-storey office block, part of which is constructed as a bridge spanning over the north loading dock.

The new factory buildings are joined to the earlier part of the factory by means of a covered bridge, which connects the ground floor of the new factory with the first floor of the pre-war building.

The new buildings are lighted generally by high-tension fluorescent tubes, supplied by the



Old and New Izal Factory Buildings

General Electric Company, Ltd., working at 3000V, and designed to give a lighting intensity at machine level of 20 foot candles. One of the views on page 94 shows the arrangement of these fittings in between the concrete roof beams. By this means, an extremely uniform distribution of light intensity has been achieved. The power required by the machines is distributed throughout from a sub-station in the basement of the new factory. The main switchgear is of Reyrolle design and manufacture.

The heating of the factory and the offices is furnished by a high-pressure hot water system, running at a pressure of 80lb per square inch, which is supplied from two Davey Paxman boilers with a combined capacity of 9,000,000 B.Th.U.s per hour. Process steam is provided by a third Davey Paxman boiler, with a designed output of 3000lb of steam per hour at a pressure of 80lb per square inch. This pressure is reduced to 30lb per square inch working pressure. The creosote pitch which is used for boiler firing is stored in two insulated chambers, and is normally kept at a temperature of 60 deg. Fah. in the containers, by means of steam coils or electric immersion heaters, at times when steam is not available. The creosote pitch is pre-heated to a temperature of 90 deg. Fah. before being fed to special Laidlaw-Drew oil burners. Heat is projected into the main workrooms, partly by radiation from heating panels, working at a temperature of 260 deg. Fah., which are shown between the roof beams in our illustrations, and partly by convection from fresh air drawn from outside the factory, and passed through unit heaters. This combination of about 60 per cent of radiant heat and 40 per cent of convected heat provides a pleasant working atmosphere.

The new Izal factory we have just described relies entirely on its general proportions in achieving a pleasing effect. No expenditure was permitted for decoration in view of the present necessity for economy in all building constructional work. Both inside and outside the factory all concrete surfaces have been left bare, just as they appeared when the formwork was taken from them. It is of interest to record that the standardised shuttering which was used to mould all the walls of the new building was originally constructed for casting the concrete monoliths for the Mulberry Harbour, which was used at the outset of the invasion of Normandy by the British and American forces.

The main contractors were Henry Boot and Sons, Ltd., of Sheffield. The heating installation was designed and carried out by the Brightside Foundry and Engineering Company, Ltd., of Sheffield, and the electrical work was done, and the equipment supplied, by F. H. Wheeler and Co. (Sheffield), Ltd. The consulting engineers and architects for the whole project are Messrs. Husband and Co., chartered civil engineers, of Sheffield and London, to whom we are indebted for assistance in the preparation of this article.

The Argentine Liner "Presidente Peron"

ON Saturday, July 16th, we were invited by Stelp and Leighton, Ltd., the London agents for the Rio de la Plata and Dodero Lines, to inspect at Southampton the new passenger liner "Presidente Peron," which sailed on Wednesday on her maiden voyage to Buenos Aires, and will make calls at Lisbon and Rio de Janeiro.

We may recall that in 1947 work was begun on three special high-class passenger liners at Vickers-Armstrong's Naval Yard at Barrow-in-Furness, for the Instituto Argentino de Promocion del Intercambio. The ships are intended for a new express service between London and Buenos Aires, and the "Presidente Peron," the first, recently completed successful trials and reached Southampton last week. The view of the liner taken during her trials shows her pleasing appearance, with fine hull lines, a swept back curved bridge structure, and single funnel painted in national blue with a black top and white bands. Her accommodation is designed for the carriage, in comfort, of only seventy-four first-class passengers, while practically the whole of her cargo spaces, with the exception of a small portion for general cargo, is fully insulated for the transport of frozen meat or fruit.

The principal dimensions and particulars of the hull and machinery are given in the table herewith.

In the construction of the ship and her machinery the latest rules of Lloyd's Register of Shipping and the Marine Division of the Ministry of Transport have been complied with, in order to obtain the highest class of certificate, and to conform with the latest rules laid down under international agreement.

Passenger and Crew Accommodation

All the spaces above "C" deck and also the amidship space on "D" deck, have been set apart for passenger and crew accommodation. The number of first-class passengers totals seventy-four, in addition to providing twelve cots for children. On "B" deck are two special suites, each with a private sitting-room, and a double and single state room and two bathrooms. These two suites are forward, and on "B" deck there are also thirty-two single-berth cabins, each with a private bathroom. On "C" deck on the port side are eighteen double-berth cabins, each with a private bathroom. The equipment of these cabins is excellent and also the decorative features.

The public rooms are arranged on "A" deck with a gymnasium and a children's playroom on the boat deck and the dining saloon on "C" deck. That room is designed to seat eighty-eight persons at small tables. The service is from the galley through a vestibule at the after end and the "in" and "out" service doors

Hull Dimensions

Length overall	529ft 6in
Length between perpendiculars	495ft
Breadth moulded	71ft
Depth moulded to "B" deck	47ft 6in
Draught	27ft 6in
Trial speed	19 knots
Gross tonnage, about	14,500
Insulated cargo capacity, approx.	315,000 cu ft

Propelling Machinery

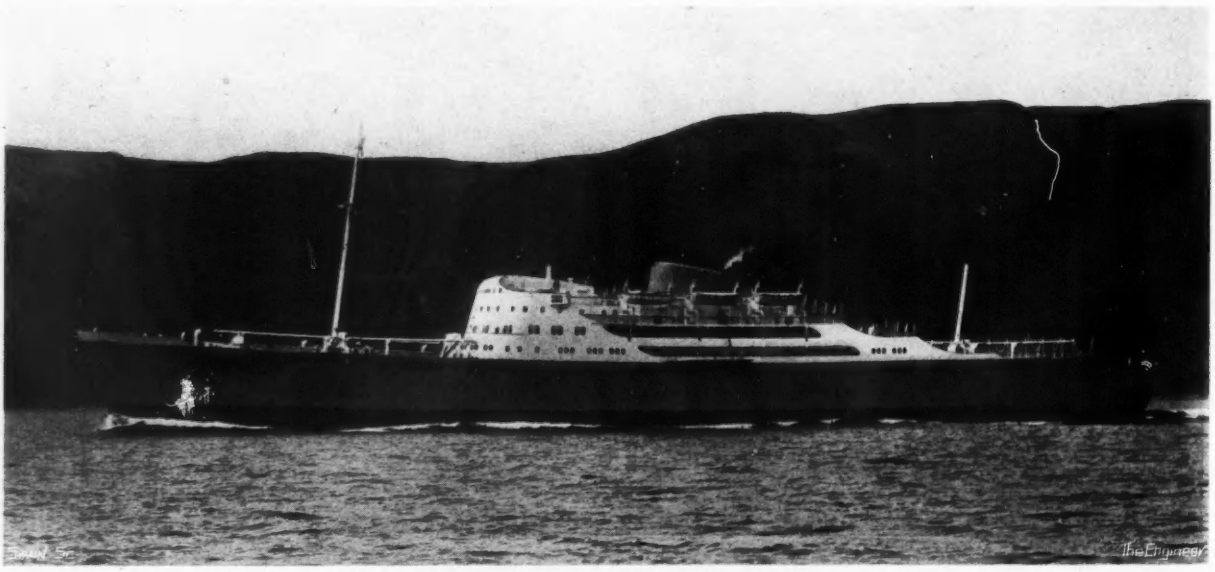
Type	Twin-screw Parsons geared steam turbines
Power maximum	14,500 s.h.p.
Service power	13,500 s.h.p.
Service propeller revolutions	130 r.p.m.
Type of boilers	Foster Wheeler water-tube
Number of main boilers	Two
Working pressure at superheater outlet	500 lb/sq in
Range of superheat control	800 deg. to about 600 deg. Fah.
Auxiliary boiler for harbour service	One Foster Wheeler
Working pressure	500 lb/sq in
Temperature of steam	750 deg. Fah.

Electrical Machinery

Number of turbo-generators	Three B.T.H.
Output, each set	550kW
Voltage	220 d.c.
Emergency dynamo	One 50kW

are, we noted, actuated by photo-ray cells. On the port and starboard sides of the main dining-room are a private dining-room and a children's dining-room respectively.

The foyer on "B" deck forms the main embarkation hall, and leads to the passenger cabins. On "A" deck a similar foyer gives access to the social hall, the main feature of which is a painting of General Peron. The corridors leading aft give access to the cocktail bar and reception room on the port side and the library and writing room on the starboard side. The lounge, aft of these rooms, is planned to cater for music and dancing, while further aft, overlooking the swimming pool, is the veranda café. The whole of the spaces on the boat deck and "A" and "B" decks aft of the bridge front are available to passengers for promenading and for games. Mention may be made of the use of hardwood veneers of rich figure, but light in colour, and the excellent workmanship in all the public rooms and cabins. The furniture and furnishings were supplied by Waring and



ARGENTINE LINER "PRESIDENTE PERON" ON TRIALS

Gillow, of London, to the designs and under the supervision of the architects, Messrs. A. McInnes Gardner and Partners, of Glasgow. The liner carries a complete laundry equipped by J. and J. Lane. The galley and main pantries are equipped with the latest General Electric Company's cooking appliances.

A feature of the ship is the air conditioning of the public rooms and *de luxe* suites on the Thermotank principle. The whole of the remaining passenger and crew spaces are ventilated and heated mechanically on the Winsor Pleno unit principle.

The crew's accommodation is, we noted, in advance of the latest international rules, requirements and recommendations, and it includes well-appointed separate mess and recreation rooms for each grade. All officers are accommodated in single-berth cabins in the bridge house and on the starboard side of "D" deck, while the crew is accommodated on "C" deck forward and "D" deck amidships.

Deck and Auxiliary Machinery

For handling cargo there are 5-ton derricks supported from the masts which are served by Laurence-Scott 3-ton electric winches. The electric windlass and the two aft warping capstans were supplied by Stothert and Pitt, Ltd., of Bath. The steering gear is of the four-ram electro-hydraulic type with telemotor controls by Brown Brothers, of Edinburgh. There are six steel Hugh McLean lifeboats—including a motor boat—which are hung in Welin MacLachlan gravity lowering davits. Six boat hoists are also fitted.

Care has been specially taken to safeguard the ship from damage by fire by subdividing the spaces in the passenger and crew accommodation by fire screen bulkheads, and by a Mather and Platt, Ltd., Grinnell automatic sprinkler and fire alarm system which has been installed in eight sections. The cargo and store rooms are fitted with Lux smoke detectors and alarms, with a detector cabinet in the wheelhouse. A steam-smothering system is also provided.

All the cargo spaces with the exception of No. 1 upper 'tween decks are fully insulated for the carriage of frozen meat or fruit. The insulation of cork and cork slab with wood facings was carried out by the J.D. Insulating Company, Ltd.

The refrigerating machinery was designed and supplied by L. Sterne and Co., Ltd., of Glasgow. It comprises four Freon compressors, each driven by vee belts from 135 b.h.p. electric motors. In all, the motor power for the compressors, the four brine pumps, the twelve circulating pumps and the two condensor water-circulating pumps amounts to 783 b.h.p.

Two of the compressors are designed to maintain a temperature of −10 deg. Cent. in the cargo spaces, and at the same time the desired temperature in the ship's provision chambers.

The navigating equipment on the bridge and in the wheelhouse includes all the latest appliances, among which we noted a Sperry gyro compass with six repeaters and a course recorder; also a two-unit Sperry gyro pilot, an Aldis signalling lamp, an echo sounder, Walkers and Pitometer logs, an Evershed rudder indicator, and an alarm system. There is a complete sound reproduction equipment and a Marconi radio installation, comprising transmitters and receivers and a direction finder, with a Cossor marine type radar equipment. Wind speed is registered by an anemometer and there are on the bridge propeller-fouled warning lights and on the engine-room starting platform indicating lights registering when oil fuel valves have closed due to low water level.

Main Propelling Machinery

The twin-screw geared Parsons steam turbines constructed by the builders are designed to develop 13,500 s.h.p. continuously at sea, with the propellers making 130 r.p.m. The machinery will also develop a maximum shaft horsepower of 14,500, while the astern turbines are designed to develop not less than 9000 s.h.p.

Steam is supplied to the turbines at 470 lb per square inch gauge and at a temperature of 750 deg. to 800 deg. Fah. Each set of gearing is of the double-reduction, articulated type, and comprises two first reduction gears, one for the high-pressure turbine, and one for the low-pressure turbine, driving secondary reduction pinions on the main gear wheel. Each first reduction gear is enclosed in a separate casing bolted to the second reduction gearcase. There are double-pocket turbine steam glands and a gland steam condenser and ejector of Weir design is fitted.

The h.p. turbines run at 5564 r.p.m. and the l.p. turbines at 3213 r.p.m., corresponding to a propeller speed of 130 r.p.m. and a service output of 13,500 s.h.p. The gears are lubricated by Drysdale Vertoil pumps which work in conjunction with AutoKlean strainers and Serck oil coolers with gravitation oil tanks. Alfa Laval centrifugal oil purifiers with steam heaters are provided.

The main condensers are Weir regenerative units with a cooling surface of 13,500 square feet, and are designed to maintain a vacuum of 28½in with a sea water temperature of 73 deg. Fah. and 27⅔in vacuum with a sea water temperature of 86 deg. Fah. The thrust blocks and tunnel shaft self-lubricating blocks are of the Michell type. The propellers are manganese bronze, with four blades and a diameter of 16ft. An electrically operated turning gear is fitted on each l.p. primary pinion and is of sufficient power to turn the main shafting one revolution in ten minutes.

Boiler Installation

Steam is raised in two water-tube oil-fired boilers of Foster Wheeler controlled-superheat design arranged for a superheat control from 800 deg. Fah. down to about 600 deg. Fah. when manœuvring. The steam pressure at the superheater outlet is 500 lb per square inch. The boilers have economisers arranged for a feed inlet temperature of 280 deg. Fah. and an outlet temperature of about 376 deg. Fah. There is one auxiliary boiler for harbour service, which consists of a Foster Wheeler single-furnace "D" design unit. The steam pressure at the superheater outlet is 500 lb per square inch and the temperature 750 deg. Fah. The economiser takes feed water at 210 deg. Fah. inlet and an outlet temperature of 325 deg. Fah. A balanced system of forced draught is used for the oil burners, Howden forced and induced draught fans being employed. Air heaters of the tubular pattern are used in the uptakes of the main boilers only, and arrangements are made for by-passing the air to the pre-heaters when steaming at slow speeds or when in harbour. The oil fuel installation consists of one Wallsend duplex heating and pumping unit, each pump and heater being designed to deal with 12,500 lb of oil per hour against pressures up to 300 lb per square inch. The pumps are Stothert and Pitt rotary displacement units. The main steam pipes and joints are made of molybdenum alloy steel with welded flanges. The engine-room auxiliary pumps and equipment are mainly of Weir's or Drysdale's design and manufacture. The machinery spaces are ventilated by Thermotank axial-flow torpedo fans and special discharge outlets in the engine and boiler rooms have ball-jointed deflecting discs. The engine-room and boiler room telegraphs are of the Chadburn mechanical type with Elliot electrical revolution indicators. For boiler feed water control an "Alfloc" injection plant and testing equipment is provided. There is also a well-equipped engineer's workshop.

Finally, brief reference may be made to the electrical generating plant, which consists of three 550-kW, 220-V d.c., B.T.-H. turbo-generator sets arranged on a flat in the engine-room. The main switchboard of Whipp and Bourne's manufacture is arranged at the aft end of the dynamo flat. Altogether, there are eleven auxiliary switchboards, to supply circuits all over the ship. There is also an emergency switchboard to control the emergency generating set, which is of 50-kW capacity, and is installed in an emergency dynamo room on "C" deck forward. The main switchboard incorporates a system of "preference tripping," so that should supply difficulties develop unessential circuits can be unloaded, while the emergency switchboard supplies all essential circuits needed in emergency conditions. For secondary lighting "Alkaline" and "Exide" battery systems are employed.

The Repair of Eyemouth Branch Line

The Eyemouth branch line in Berwickshire, which connects Eyemouth with Burnmouth on the East Coast main line of the Scottish Region, was officially reopened on Wednesday, June 29, 1949. The line had been closed to all traffic for a period of over ten months on account of the flood damage which followed the unprecedented rains of August last year.*

Due to the heavy flooding of August 12, 1948, the Eyemouth branch line was seriously damaged, in common with the main trunk railway on the section between Berwick and Dunbar and a number of other lines in the border area. Apart from damage to the track and certain slips, major damage occurred at Eyemouth viaduct.

This viaduct carries a single line of railway across the Eye Water. It is 332ft in length and consists of six lattice girder spans carried on piers. The piers are built of concrete with brick facing and the height of the viadict from rail level to water level is 60ft.

Normally the river is confined beneath span No. 5, but during the flooding the width of the Eye Water extended under all the spans. Due to the scouring action of the flood waters the gravel underlying the centre pier—No. 3—was washed away and the pier collapsed, leaving the superstructure suspended. The ends of the suspended girders were secured temporarily by means of ties and wedges.

A mill lade supplying water to the Eyemouth Milling Company, Ltd., is situated between piers Nos. 1 and 2. It was found that considerable scouring had occurred in the bed of this mill lade, extending some distance under the foundations of pier No. 2.

Remedial measures were begun by rebuilding pier No. 3. Steel sheet piling was driven 30ft into the gravel to form a permanent cofferdam, in which the mass concrete foundation of the new pier was constructed at a depth of 12ft below bed level. The new pier was built of brick facework with concrete filling.

Pier No. 2 was enclosed in a permanent cofferdam of steel sheet piling carried 25ft down to rock, concrete being packed into the scoured portion under the foundation and between the pier and the piling. A training wall of steel sheet piling driven 25ft down and capped with concrete now forms the other side of the mill lade. The scoured portion of the mill lade was brought up to within 1ft of bed level with packed material from the collapsed pier, which was also used for protective works to the banks of the mill lade at pier No. 2.

The bed of the mill lade now consists of a concrete mat, 1ft thick, on top of the packed material, which also acts as a strut between the walls of steel sheet piling.

Pier No. 4 is founded on gravel overlying rock. In this case, permanent steel sheet piling was driven 12ft down to rock all round the pier and the space between the pier and the piling was packed with concrete. A new cut-water was also provided.

The original foundations of pier No. 5 were examined and found to be on rock. A new cut-water and a concrete wall were constructed at this pier, the concrete wall being carried down to rock along the river side of the pier and round one end as a protective measure.

To enable the work at piers Nos. 4 and 5 to be carried out in the dry, the river was diverted through a new channel in the vicinity of pier No. 3. This channel has been left, and will serve as an additional channel for the river in times of flood.

The work at the mill lade was carried out in the dry, at intervals to suit the convenience of the Eyemouth Milling Company, who co-operated in the work of repair and reconstruction with the contractors, Sir Robert McAlpine and Sons (Scotland), Ltd.

* See The Engineer, August 20 and 27, 1948.

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NOTICE TO READERS

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WESTERN ECONOMICS AND AMERICAN IMPORTS

How gladly we would evade the responsibility of writing upon economic subjects if we could! But we cannot. For even more particularly than usual in the present instance engineering firms are likely soon to be directly or indirectly affected by an economic event. Sir Stafford Cripps has promised this country a substantial cut in its imports from dollar areas and, as Mr. Eden pointed out in the recent debate in the House of Commons, the consequences are likely to be disagreeable. For the loss of imported "dollar" machinery must handicap productive capacity; while even if threatened shortages in raw materials can be avoided by importing substitutes from non-dollar sources the prices to be paid will be higher and must inevitably add to costs of producing finished products. Moreover, since price competition in the United States is growing in intensity the export of goods for sale in that country which engineering firms, amongst others in this country, are being encouraged to undertake, is likely to become even less profitable than before. In fact, this new cut in imports into this country from dollar areas, essential though it obviously is, necessarily intensifies that divorce of the Western world into two distinct economic entities, ruled over respectively by the dollar and sterling, which it continues to be the very object of statesmen and economists to avoid. Multilateral trading is the ideal that we seek to bring about. But a harsh economic situation forces Britain into bilateral agreements and the reduction of transatlantic trade.

Yet hard though we find our economic situation, that very situation must seem to a detached observer to present a curious paradox. For surely a country that is producing very substantially more than it has ever produced before, a country that has, in addition, so well recovered from a recent war that it has achieved an overall balance of its oversea trade and is thus paying its way, should not only be prosperous but untroubled by serious economic problems! Yet that it is troubled by such problems is a fact that cannot be gainsaid. Nor are these problems altogether new. Before the recent war this country was already finding difficulty in maintaining a balance in its dollar payments, despite multilateral trading methods. Many other countries in Europe were finding the situation still more difficult. The disrupting effect of war upon European productive power has therefore merely intensified a malaise that existed in the world's economic system long before war broke out. Nor can Britain and the other nations of Europe be held wholly responsible for their inability to balance their trade with the United States. For since 1918 America has been a creditor nation pursuing a policy more suited to the situation of a debtor. Before the war, whilst pressing her exports strongly upon the world, she continued to impose trade barriers to discourage imports. Such a policy could be supported (for the oversea accounts of every nation must willy-nilly be somehow brought into balance) partly by accepting and storing immense quantities of useless gold as payment and partly by lending money abroad which the borrowing nations had, under then existing circumstances, no chance of repaying. To-day, very similar conditions rule. Britain and Europe wish as soon as possible to start the repayment of those loans that the American peoples are so generously stinting themselves to provide. But unless and until imports into America plus American investment abroad together overbalance the value of American exports, repayment cannot be begun. Indeed, Britain has already reached such a balance in her oversea trade that were it possible to divert a proportion of her exports to the American market the need for further Marshall Aid would rapidly pass. But there is, we fear, little appreciation of that situation by American industrialists and businessmen and even less among the general population. The Americans, in fact, are not consciously pursuing a course that is detrimental to the economies of other nations, and it is, indeed, a great deal to expect of a people that in the short space of a single generation they should appreciate that fiscal changes are required of a debtor nation that becomes a creditor. For the necessity for those changes is far less obvious to the peoples of a nation experiencing that alteration in its circumstances than it is to the people of such a country as Britain which has suffered a variation of circumstance opposite in character. Yet if the economic systems of Europe and of America are not to be driven apart by events—European nations will not for ever continue to accept American dominance if they can find sufficient supplies of raw materials and sufficient markets within their own areas, nor will Americans for ever stint themselves to provide continuing Marshall Aid—we see no end but the eventual acceptance by the Americans of the need, and indeed the desirability in their own interests of accepting and, in fact, of encouraging the import of large quantities of European goods. So far the point has been recognised only to the extent of a reduction of the tariff wall, substantial in extent but insufficient to meet the need. Were America to go "free trade" to-morrow (as Britain in somewhat similar circumstances went free trade last century), remove import barriers altogether, and adopt an internal monetary system that would encourage imports (few things seem less likely than these!), the world—and America—we believe, would soon reap a benefit.

But if, then, we believe that it is American, not European or British, economic policies that are dividing the Western world into two distinct economic areas, that is no reason for holding up America as a scapegoat to explain our own economic ills! Britain has now, as always before, to live in the world as she finds it. Her troubles are her own and cannot be laid on the shoulders of any other nation. If we cannot sell much to America we must, as soon as we can, buy as little as need be from her. That is, in fact, the course that is being impressed willy-nilly on the sterling area. That area must sell where it can and is selling its goods and buy from similar sources. Our statesmen and economists should, of course, continue frankly and in friendship to state this country's views and those of the Commonwealth to the Americans, and as much transatlantic trade as possible should be maintained, particularly with Canada which is itself suffering from dollar shortage. But if, as seems to us inevitable, when economies become divorced one from the other, differences of price structure arise, we do not think this country should so far accept American dominance as to try to force our prices down unless, indeed, they fail, as we fear they already threaten to fail, to remain competitive in the remainder of the non-dollar world. We do not believe the Western world can be nearly so rich or strong divided into two nearly watertight economic systems as it could be as one economic unit. But the choice as to which is to be is not wholly Britain's.

CHANGE IN THE FARM

THIS year's Royal Show, which was held at Shrewsbury a couple of weeks ago, was the largest yet staged by the Royal Agricultural Society of England in the 110 years of its existence. That perhaps is not surprising in view of the important place which agriculture now occupies in the national economy. But a visit to the Show emphasised once again the changes that have already been effected, and the changes that are continually taking place, in the science and practice of farming. Not that it should be thought that any of the customary features of the "Royal" were

missing. It was a pleasant diversion, for instance, to inspect the prize cattle and horses, to admire the magnificent display of flowers, to be able to see that several old-established rural crafts continue to be pursued with diligence and fine workmanship, and also—let it be acknowledged—to have the opportunity to appreciate the exhibits of cider and perry! But, as engineers, our main preoccupation was naturally with the very large section of the Show devoted to implements and machinery, a section which has been accorded increasing prominence in the post-war years. Not a few visitors at Shrewsbury commented that the Show was becoming to a large extent an engineering exhibition; an opinion which was strengthened by the fact that this year's programme of events in the Grand Ring included a parade of British-made tractors.

As we have endeavoured to show by the descriptions of some of the exhibits which are concluded elsewhere in this issue, the machines and implements now being provided by engineers for the service of agriculture lack nothing of that technical efficiency and robust construction of which British manufacturers may be justifiably proud. In the space of a comparatively few years the engineering industry has accomplished the worthwhile, though frequently arduous, task of mechanising British agriculture, and in recent years it has had much more encouragement from farmers themselves than was forthcoming in earlier days. By the works of engineers a great deal of the drudgery of farming has been removed, time-saving methods have been introduced, and productivity has consequently been increased. These are but a few of the matters that indicate changes in the farm, changes that become more obvious when, on an occasion like the Royal Show, farmers and farm workers may be seen making a keen, if sometimes critical, examination of the thousands of implements displayed. Herein, we suggest, may be found a pointer to the present and future responsibilities of agricultural engineers and implement makers. They are aware that their task does not end with the production and sale of the machines which modern farming demands, for they know that intelligent operation and careful maintenance are necessary if those machines are to render efficient service. To-day, the British agricultural industry stands in need of more trained people who are competent to give instruction to farmers, farm workers and also to implement dealers about the construction, operation and care of farm machinery.

It is true that this is a problem which is not being overlooked, and it is also true that some of the agricultural machinery manufacturers themselves have for a long time made commendable efforts to provide adequate technical instruction about their products. But progress appears slow, and teaching facilities have not kept abreast of developments in agricultural machinery. A committee, under the chairmanship of Dr. Thomas Loveday, which was appointed in 1944 to advise the Ministers of Agriculture and Education on all aspects of agricultural education, has touched upon this question of machinery instruction in an interim report which appeared a few days before the Royal Show opened. The committee is agreed about the need for such instruction, but its report conveys the impression that very little expansion of the existing resources can be expected at present. A year ago, however, the Institution of British Agricultural Engineers submitted, at the Loveday committee's request, a distinctly practical scheme for training farm machinery operatives and agricultural mechanics. It is therefore somewhat disappointing to observe that the committee, whilst recognising the merits of that scheme, finds itself prevented by its terms of reference from making any recommendations about it. Exhortations to greater effort are apt in these days to wear a bit thin, but the Institution will unquestionably enhance its already high reputation if it continues undeterred to disseminate knowledge of the many and varied aspects of agricultural engineering. With the support of the implement makers and of the universities and other bodies already providing courses in agricultural engineering, it can, we believe, contribute much to the solution of those problems now arising as a result of mechanical changes in the farm.

Literature

Distribution of Deformation (A New Method of Structural Analysis). By C. V. KLOUCEK. English edition. Prague. 1949.

THIS is an English translation, somewhat abridged, from the Czech and German originals, but while the text is in English the mode of presentation still remains essentially Continental. It is undoubtedly a valuable addition to the growing collection of books on distributive methods applied to framed structures. Founded on the principle of slope deflection, it is a handbook to the technique of distributing deformations as alternative to the more widely popular "moment distribution." Once the principle of distribution had been established, the particular function to be distributed became a matter of choice, and since the engineer is primarily interested in bending moments, it was natural to develop a method to determine these directly. Dr. Kloucek is out to show that it is quicker and often more convenient to distribute joint deformations and then to deduce the moments from the slope deflection relations. This he does by means of numerous worked and carefully illustrated examples. Most of the ground covered has by now been developed independently in this country, but the book forms a useful summary of technique, worth detailed study by anyone who has much to do with computations of this type.

In Part I, pages 1–240 (which originally appeared in 1940), after a chapter devoted to analysis of the process involved, the necessary formulæ are developed in restricted form, applying to framed structures whose joints can rotate, but not move in space, such as continuous beams and frames, closed frames and multi-storey frames in restricted conditions.

In Part II, pages 241–508 (which appeared in 1947), the technique is extended to cover movements as well as rotation of joints. This section is largely devoted to Vierendeel trusses and multi-storey frame buildings.

Elementary Mechanical Vibrations. By A. H. Church. First edition. London: Pitman, 1949. Price 22s. 6d.

SEVERAL textbooks on the elements of mechanical vibrations have been published in the last few years; and any addition to this number must aim to put forward something which will recommend itself to the student or the engineer by dealing with some special aspect or presenting a new viewpoint. Professor Church's object has been to write a practical introduction to the study of vibrations which will require a standard of mathematics no higher than is usual in engineering courses and which will allow the engineer to deal with the ordinary day-to-day problems. In this he has been successful and has produced a concise and orderly statement of the fundamentals of mechanical vibrations.

The subject is necessarily rather mathematical and this has caused many writers to present a cryptic statement of the basic mathematics, unrelated to the practical problems. The average engineering student usually finds the study of vibrations difficult for this reason. He is presented with a series of differential equations, which he is told represent various conditions of vibrating systems, but as far as he is concerned, the main preoccupation is the solution of the equations; how to relate them to the engineering problem, why they represent the particular vibratory condition of a machine element, how this vibrating condition can be cured and why it needs curing are questions which are seldom answered to his satisfaction. There is an urgent need for a laboratory to be set aside in all universities where demonstrations of the basic vibrating systems can be given and the student can, in the early stages, verify for himself the physical reality of the results the mathematical equations yield, and relate in his own mind the mathematical abstraction and the actual vibrating component. Professor Church has had experience of the students' difficulties and has quoted practical cases of the engineer's problems at each stage throughout his book. In particular, he has given at the end of each chapter, a collection of useful examples, with answers attached, based on actual machines, which, besides allowing the student to check his grasp of the subject matter, should show him how to apply what he has learnt to real problems.

After defining the terms used in vibration studies, Professor Church deals in successive chapters with undamped and damped free and forced vibrations, with one degree of freedom. The energy method is briefly referred to and the principles of the vibrograph and torsiograph are described. There are useful sections on critical, over and under-damping and constant damping. Undamped vibrations with two degrees of freedom are introduced in the next chapter, including a note on the dynamic vibration absorber. The chapters on multi-mass torsional systems are brief but practical; the Holzer method for determining the natural frequencies of multimass systems is outlined for both in-line and branched systems, and two examples worked out in detail, while the determination of equivalent torsional systems is similarly treated. Lateral vibrations of multimass systems are dealt with by the Rayleigh and Stodola methods, and the more general method, applicable for the determination of higher natural frequencies, attributed to Prohl and Myklestad, is also described and illustrated by examples. The volume is completed by a chapter on the elements of engine balancing. It is rather sketchy but provides at least some idea of the fundamentals.

There are inevitably some omissions: Professor Church has deliberately made no reference to self-excited vibrations, harmonic analysis and damped systems of more than one degree of freedom and it was probably

wise to leave out these more difficult topics in an elementary book. On the other hand, most mechanical engineers have sufficient knowledge of electricity to benefit from a brief treatment of the electrical analogue. He also admits that he has not given a bibliography. This is a pity, since a complete list of papers would have considerably enhanced the general usefulness of the book. These minor points apart, however, there is no doubt of the value of the work to all those who need a concise and practical introduction to the subject of mechanical vibrations. The book is well produced, but the paper—particularly of the title pages—is of indifferent quality.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

OIL SEALS

SIR,—I was interested to read the letter written by Mr. E. R. Dibben which appeared in your issue of July 1st.

I find that I agree entirely with his definitions of "rotary shaft oil seals" and "hydraulic packings," and with the fact that both terms are loosely applied. I also agree with his remarks regarding the incorrect principles in the design of the packing which formed the subject of my original paper.

I cannot agree, however, that I could have saved time by consulting with a member of the Oil Seal Manufacturers' Association, as this was done at the outset. All the better-known manufacturers of seals and packings were asked to submit their proposals for conditions which must be regarded as ideal. The tests have so far revealed that no answer gives 100 per cent sealing.

Mr. Dibben states that one type of seal proved "extremely satisfactory." Doubtless these are the manufacturer's words as I have been to date denied the pleasure of testing a seal which could be so described. The seal referred to is probably one which gave a performance that gave hope of achieving 100 per cent sealing by improvements.

Our tests proceed and I suggest that Mr. Dibben saves further waste of your valuable space by calling to discuss the matter personally.

Sunderland, July 13th. B. COOKE

LOCOMOTIVE INTERCHANGE TRIALS

SIR,—The summaries of the report on the above trials as published in the technical Press show that a great deal of valuable data has been gathered in to guide new design or improvement to existing locomotives. In future construction the Railway Executive have already stated that the creation of twelve standard types will suffice to meet all requirements on British Railways; these will gradually replace the older or less efficient engines.

Admirable as the report may be as a preliminary to intensive research, it seems to me that the cart is being put before the horse. The fundamental question is that of coal, its source, distribution and handling. The combustion of this fuel is applied to the creation of motive power for traction through individual steam engines and prior consideration should be given to it rather than the medium through which it is so converted.

Before 1923 the numerous railway companies solved their coal problems in various ways, those serving the coalfields obtaining supplies from their own territory and adapting their locomotives and firing practice to suit the fuel available. Others not so placed had to make the best bargain they could, supplies coming over other companies' lines or perhaps by sea. After the amalgamations of 1923 three of the four groups tapped all coalfields except the Kentish, which partly supplied the Southern Railway. This company had to go to South Wales, Yorkshire and the Midlands for the remainder.

Under nationalisation the position is that one railway is serving all coalfields; except that the four groups are now reconstituted as six Regions, the position is but little changed and there has been no large-scale redistribution of locomotive stock, so that things remain much as they were. As regards the future and the creation of twelve standard locomotive types the situation is entirely different and it appears to me that a definite long-term coal policy should be laid down in collaboration with the National Coal Board before design of boilers is completed; but there is no hint of this in the published summaries of the Report.

The qualities and characteristics of coal varies between coalfields, to some extent between collieries in a coalfield and even in seams in any one pit. In bygone days locomotive coal could be selected from a particular seam and contracts entered into, but in recent years, under Government control, the railways have had to take less suitable grades. Highest efficiency in combustion and output of steam would be obtainable by allocating a particular grade or grades to each of the twelve standard locomotive types, designing boiler and superheater surfaces, firebars, brick arches, &c., to suit the grade allocated. However, as each locomotive type will be scattered over the entire railway system, that would necessitate a great deal of uneconomic wagon mileage. On the other hand, if the standard types of locomotive are rigidly standard, without variation in detail, they will put up a better performance in one part of the country than another, merely because the coal supplied from the nearest source happens to be of better quality or more suited to them.

Again, are all twelve types to draw indiscriminately from the same supply of coal allocated to a depot or will there be some selection, express engines having first call on the best lump coal, the small coal and dust going to the pick-up freights and shunters, and the bulk, the intermediate qualities, to the ordinary passenger and freights? The Western Region's use of the high level coal stage and tip wagons facilitates selection, but the mechanical coaling plants elsewhere are against it.

Having experience of the use of a screened coal, of uniform size rather larger than road metal, I can testify to its benefits, and it would effect economy in consumption if the collieries sent out all hard locomotive coal in this form. The fireman's work is eased, no trimming or use of coalpick is required, coal feeds more readily to the shovelling plate, it is more easily handled in firing and the footplate keeps cleaner. Due to the even air spaces in the fuel, combustion is improved and there is not the tendency for holes to form in the firebed as with irregular lumps.

From the results of trials with the fourteen existing types the report makes a number of recommendations for future design. Some of them apply to all locomotives but those advocating the largest boiler and grate area permissible should be limited to the standard types to be engaged in similar duties to those in the trials, namely, services in which a high power output is sustained more or less continuously over the turn of duty. High thermal efficiency is stressed here in its relation to maximum output rather than its effect on overall coal consumption.

The above services probably amount to 20 per cent of the whole, and in the 80 per cent of less exacting work there will be many cases where a minimum grate area will effect an overall coal saving. Large grates are wasteful of fuel in engines engaged on intermittent working, which involves standby losses. If short and infrequent peaks of output produce a high rate of combustion and a drop of thermal efficiency in engines having a small grate it is not of much consequence taken over the whole turn of duty.

One statement in the report requiring elucidation is that relating to the engines of the Western Region, which are said to have grates and smokeboxes specifically designed to suit Welsh coal. If this is taken to mean that all Western Region coal is drawn from certain of the South Wales valleys and Monmouthshire, it quite overlooks the large quantities of hard coal which it has been customary to obtain locally in the northern section, stretching through the industrial areas of the Midlands to the Mersey ports. There is no lack of experience in the firing of hard coal on the Western Region and it cannot be held that their enginemen are unaccustomed to the technique. What is probably meant in the report is that a coal of high calorific value and low ash content is needed for the development of sustained high output from a narrow firebox, and that small refinements in the design of grates and smokeboxes can assist in this direction.

Such practice was sound enough in the past, but under present circumstances it is in the national interest that first-class coal lying near the sea should go for export and coal of a lower grade drawn from inland sources allocated to locomotive use, boilers being designed to suit.

A careful survey of the coal situation as it affects locomotive operation would point the way to many economies and bring to light practices out of keeping with the times.

H. HOLCROFT

Chipstead, Surrey, July 9th

BOOKS RECEIVED

Water Treatment. Second edition. By G. V. James. Surrey: The Technical Press, Ltd., Gloucester Road, Kingston Hill, Surrey. Price 30s.

The Technique of Building. By E. G. Warland. London: English Universities Press, Ltd., St. Paul's House, Warwick Square, E.C.4. Price 21s.

First Steps in Engineering for the Apprentice. By G. McAlpine. London: Percival Marshall and Co., Ltd., 23, Great Queen Street, W.C.2. Price 3s.

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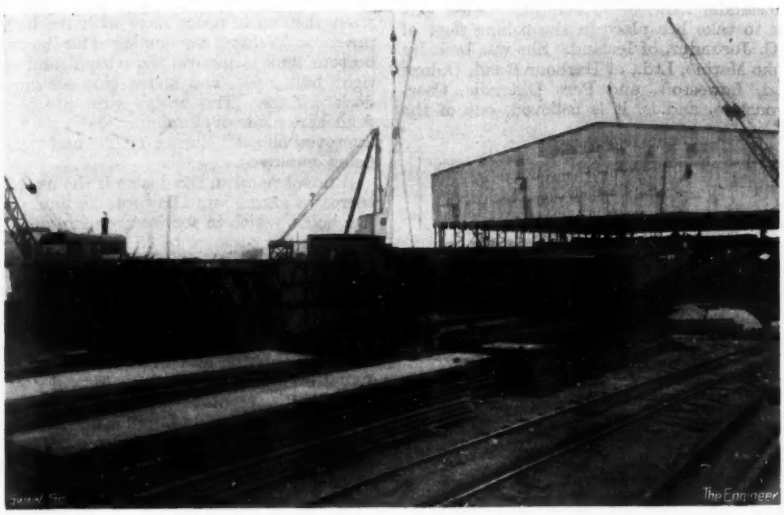
All-Welded Steel Barge Construction

WE recently took advantage of an opportunity to visit the works of the Tees Side Bridge and Engineering Works, Ltd., at Middlesbrough, to see an interesting method of all-steel fabricated barge production, which the company has developed. This work was undertaken after a request had been made to the firm by two large lighterage companies on the Thames for assistance in making good the serious deficiencies in dumb barges, which resulted from war losses and the re-building restrictions imposed between 1939 and 1945.



FIRST AND SECOND STAGES IN ASSEMBLY OF BARGES

During the war years, the Tees Side Bridge and Engineering Works, Ltd., acquired a considerable amount of experience in the building of naval craft, and for the new work it was decided to use this experience and apply the principles of welded pre-fabrication to barge building.

The extent of the initial order for barges and the urgent demand for craft was such that the company decided to introduce completely unorthodox methods in order to expedite the work and simplify construction so that it could be carried out by constructional steelworkers. A new system of site assembly, based upon moving line construction methods, was evolved and, on permission being obtained from the Admiralty, a site on the River Tees was acquired and laid out for the work in 1945. The first large order for the barges was placed by William Corey and Sons, Ltd., and that company agreed to certain modifications in design which would facilitate the introduction of the proposed new methods.

The first barge built on the new site was waterborne in April, 1946, and since that time some 450 craft of various standard types and sizes have been built. With the new system, the firm states a peak production of sixteen craft per month has been attained. One barge was waterborne in eleven days from the time of its keel being laid, and it was at work on the Thames nine days after.

The makers point out that barges are not only built more rapidly with the new system than with orthodox methods, but that they are cheaper, and require some 11·6 per cent less steel to complete. The degree strength of the welded craft is proportionately high and repairs can be quickly and easily effected.

When the scheme was evolved, and prior to the actual laying down of the assembly site, it was necessary for the firm to prepare accurate timing estimates for the various processes involved—assembly, tack and final welding, testing, painting and transfer to the river. From these estimated times was determined the length required for the proposed assembly line. It was ultimately decided to lay down fourteen building berths and three standage berths in the line. On the same basis, the personnel requirements and the handling facilities were determined. Shop and site welding sequences were completed, and the amount of pre-set required on plate work was determined, particular attention being given to the fore and aft swims where shaped and curved panels were used. In the design stages, the purchasers of the barges had agreed to the use of certain locating holes on a limited scale, and this concession facilitated to a considerable extent the jig assembly of the various units.

In the description which follows we deal mainly with the construction line laid down for the barges, but it will be appreciated that a considerable amount of accurate and elaborate jigging and tooling had to be installed in the constructional shops which were responsible for the manufacture of the pre-welded components. This initial work was of the utmost importance to the whole scheme in order to make possible the interchangeability of components at the erection site and ensure an adequate supply of parts to meet the construction programme.

The lay-out was designed for the construction of nine types of barges, of from 100 tons' to 300 tons' capacity, varying in length from 77ft to 87ft 6in, and width at the gunwale from 17ft 9in to 23ft. A typical barge, for which some 55 tons of steelwork is required, has forty-three major pre-fabricated component parts, all of which are delivered to the building line ready for assembly.

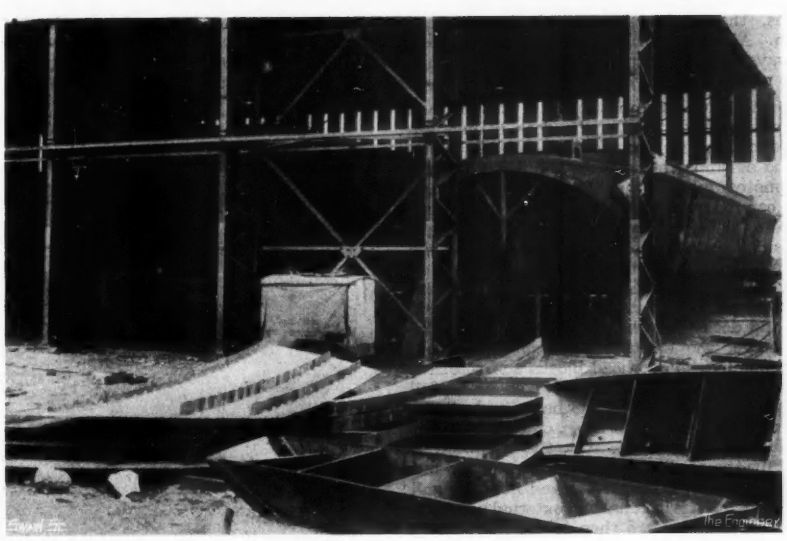
The Barge Assembly Line

The barge assembly line, some views of which we are able to reproduce, is 477ft long at the water's edge. It consists of two parallel rails, set 42ft apart, and supported on short columns some 3ft 3in above ground level. Each barge is carried through the successive assembly stages along the rails on double-flanged wheeled carriages. A barge rests on the same pair of carriages from the second stage in building until it is waterborne. No attachment is provided between the barge and its two carriages, as the weight of the craft gives sufficient frictional grip on the timber-covered upper faces of the carriages to hold the assembly in alignment as it is moved along the rails.

The trailing wheel on each carriage is fitted with a spur ring which merges with a runner pinion coupled through a ratchet to a 6ft long lever arm. With one man operating each lever, a pair of carriages carrying a barge can be propelled along the track with little effort.

The 386ft of track used for actual assembly of the barges has a gradient of 1 in 252 to facilitate movement of the barges by hand. A ramp, 91ft long, forming a continuation of the assembly line falls some 17ft to the water's edge. The incline of the ramp is arranged in four stages, the lowermost one of which is in line with low water level. The inclines were determined in accordance with the change in the centre of gravity of a barge as it moves down towards the water.

At the head of the assembly line is a large stockyard in which the various component parts are stored. This stockyard is served by a 7-ton derrick, which is used to handle the component parts and jigs in the initial assembly stage.

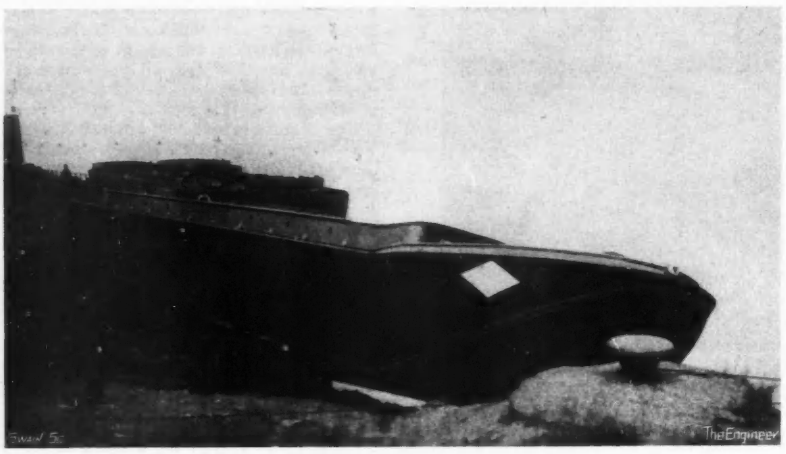


THIRD STAGE OF ASSEMBLY

In the first stage of assembly, the bottom plates of a barge are laid on a table at the head of the tracks. This table, arranged between the rails, is 35ft long by 18ft wide, and smaller tables at each side of the track support the outer ends of the bottom plates. The main table is mounted on four 15-ton hydraulic jacks with a stroke of 6in. When the bottom plates have been laid down erection jigs are introduced and fixed in position by means of bolts in location holes in the floor angles of the

bottom plates. Each erection jig consists of two rigid lattice girders which, when they are in position, are locked by beams fixed across their top booms. With the jig in position, the barge side shell plates are positioned and temporarily connected to the lattice girders. The deck and coamings are then erected and each part of the complete assembly tack welded in position.

The platform or table on which the barge rests is then raised 6in by means of the four hydraulic jacks and the carriages are introduced beneath the ends of the barge. The table on being lowered leaves the barge suspended on its two carriages. By means of the jacking gear on the carriage wheels the assembly is then moved along to the second erection stage, where further jigs are introduced to position the swim steelwork. When the swim structures have been tack welded in position, the forward swim nosepieces are added and on the aft swim



BARGE BEING LOWERED DOWN RAMP

the budget or rudder. During the following erection stages, the barge passes along a shed, 146ft long and 70ft wide, built over the assembly track. This shed covers the main welding berths, the testing berth and the painting berth. Along its full length are three overhead runways carrying hand-operated lifting blocks of 1½ tons' capacity.

At the third assembly stage in the forward end of the shed, the various deck fittings are introduced on a barge, and full welding of the tacked assembly begins. In the foreground of the photograph showing this stage of construction can be seen swim nosepieces and deck-plates as delivered from the fabricating shops. The small plates to be seen projecting from the side of the barge are temporary fittings used to draw the parts together for welding; they are removed at a later stage. When the bottom, side and deck joints have been fully welded at this stage, the erection jigs are dismantled, lifted out by the overhead blocks and returned to the head of the line. At the next stage, full welding is completed on the barge and all the welds are submitted to a water test. At the conclusion of the water test, the steelwork is dried for the application of protective solutions on the inside bottom plating and flooring, and the balance of the internal and external painting. The ceiling plates are then laid on the floors and welded in position before the barge is moved out of the shed to the top of the ramp.

The equipment used for lowering the barges down to the water consists of two 15-ton winches operated by 25 h.p. electric motors. This equipment and its control platform is situated at one side of the line well clear of the barges moving down the ramp. Each barge is propelled by hand on to the first slope of the ramp, and in this position automatic stops come into effect to hold the carriages. Snatch blocks from the winches are then coupled to each carriage and, on the stops being released, the barge is gradually lowered to the flotation stage. Prior to the lowering of a barge down the ramp, wire cables are attached to the carriages to facilitate their recovery after a barge is waterborne. The carriages are designed to fall outwards as the barge lifts off them, and they are retrieved by a 10-ton derrick at the top of the ramp. It will be appreciated that with this method the barges can either be lowered to the bottom of the ramp when the tide is out, so that they float clear of their carriages with the rising of the tide, or they can be lowered down the ramp at full tide.

When afloat, the barges are drawn alongside an adjoining wharf where special painting is completed, and light fittings installed, and, in certain cases, hatch covers are fitted.

The Icelandic Trawler "Jorundur"

AFTER carrying out successful trials, the Icelandic trawler "Jorundur" sailed this week to take her place in the fishing fleet of Mr. G. Jorundur, of Iceland. She was built by Brooke Marine, Ltd., of Harbour Road, Oulton Broad, Lowestoft, and Port Dinorwic, Caernarvonshire, and is, it is believed, one of the largest vessels of her type to be built on the East Coast.

The trawler, a view of which is reproduced below, has a length overall of 167ft, with a breadth moulded of 28ft and a depth moulded of 15ft. She has a fish hold of 12,000 cubic feet capacity, and a meal hold of 2500 cubic feet, which, if needed, can be combined to form one hold of 14,500 cubic feet. Other hull capacity provides for the carriage of 20 tons of cod liver oil, while in cross bunkers and double-bottom tanks aft 100 tons of oil fuel is carried, some 23 tons of fresh water being stored in double-bottom tanks forward, and 4½ tons of lubricating oil in double-bottom tanks aft.

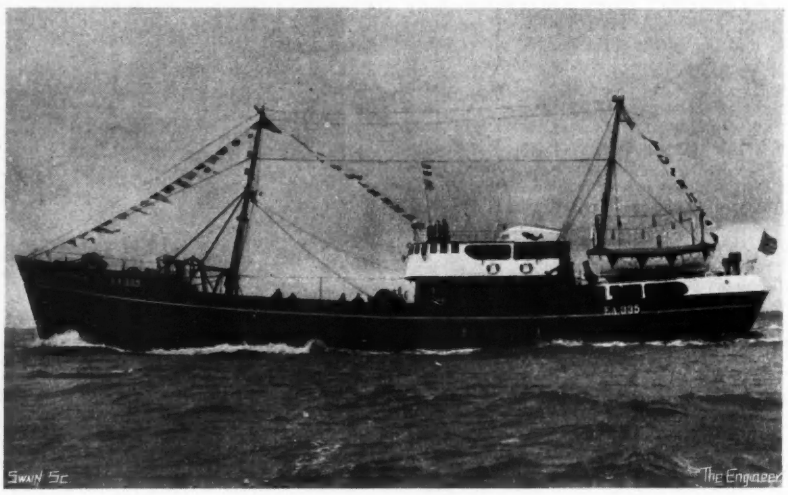
The trawler has been designed and built in accordance with Lloyd's Register 100 A1 Motor Trawler Classification, and she incorporates in her hull structure additional strengthening in accordance with the builder's practice. Welding was employed for the double-bottom tank structure, the oiltight and watertight bulkheads, and the engine seatings and deck casings. The bridge structure and the funnel are made of aluminium alloy, the Lloyd's approved alloys "Noral 65 S.T." and "51 Sq" being employed.

A novel point in the design is the use of non-corrosive aluminium alloy for the lining of the fish holds, which in service are maintained at a constant temperature of 35 deg. Fah.

As shown by the accompanying engraving, the hold design utilises aluminium pound boards of standard size, which are interchangeable and are easily cleaned. Cooling is effected by means of an overhead grid. The cod liver oil plant is modern in design and was supplied by the De Laval Company, of Sweden. It will deal with about half a ton of treated livers per hour. For that purpose about 13 b.h.p. is needed in motor power and some 240 lb of steam. Place and auxiliary services are also left for a fish meal plant built to deal with 10 tons of fish offal per day, the meal so produced being bagged and stored in the meal hold. The meal plant was designed by the Farrar Boiler Works, of Newark-on-Trent.

A further interesting feature is the trawl winch which is of the Robertson "Arctic" pattern, and is worked hydraulically by a small diesel engine coupled to a Vickers "VSG" hydraulic pump driving a hydraulic motor attached to the winch. The winch has two drums taking 1000 fathoms of 3in warp, and is designed to take a mean pull of 5½ tons at a speed of 200ft per minute.

Special provision has been made for the accommodation in comfort of the captain and his crew of thirty-nine persons. Mechanical ventilation is fitted throughout, and the standard for the cabins and the accommodation is a very high one. The bridge is replete with the latest navigating appliances and provision is made for the fitting of radar equipment at an early date.



TRAWLER "JORUNDUR"

Propelling and Auxiliary Machinery

The main engine consists of an eight-cylinder Mirrlees diesel engine of the direct air reversing type, designed to develop continuously 950

b.h.p. at 300 r.p.m. The drive to the propeller shaft and the Stone "Heliston" manganese-bronze propeller is taken through a Bibby flexible coupling and an S.L.M. combined oil-operated clutch and 2 : 1 reduction gear. The auxiliary machinery includes a five-cylinder Mirrlees diesel engine with a rating of 225 b.h.p. when running at 500 r.p.m. This engine drives a 50-kW, 110-V Brush generator and the "VSG" pump for providing the trawl winch with power. A McLaren four-cylinder diesel engine developing 88 b.h.p. at 1000 r.p.m. drives another 50-kW Brush generator set. There is also a twin-cylinder McLaren engine rated at 44 b.h.p.

ALUMINIUM-LINED FISH HOLD

at 1000 r.p.m. which is coupled to an air compressor having a displacement of 39 cubic feet of free air per minute at 350 lb per square inch. This unit also drives through a clutch a self-priming general service pump with an output of 40 to 50 tons of water per minute at 40ft head.

To utilise the heat in the main engine exhaust gases a Clarkson composite oil-fired exhaust gas boiler is installed, which furnishes steam for shipboard requirements. The boiler has a designed maximum evaporation of 1650 lb of steam per hour at a pressure of 75 lb per square inch. The Reid anchor windlass is electrically operated, and the steering gear is electric-hydraulic, by Donkin and Co., Ltd.

Some Trial Results

During recent trials a speed of 12·4 knots was attained with the engine developing 870 b.h.p. In the starting and stopping tests, full speed ahead to stop, using full power astern, was 1 min. 21 sec. while from stop to full speed ahead took 1 min. 30 sec. Throughout the trials torsional vibration tests were carried out on the engine, and it was found that no excessive criticals could be observed throughout the full range of engine speed. In the turning trials, when turning in a circle of 70 yards at full speed, the angle of heel was small, which demonstrated one advantage of the aluminium superstructure. The time to complete a turning circle to port at full engine revolutions was 3 min. 15 sec., while the time required to complete a turning circle to starboard at full engine revolutions was 3 min. 28 sec.

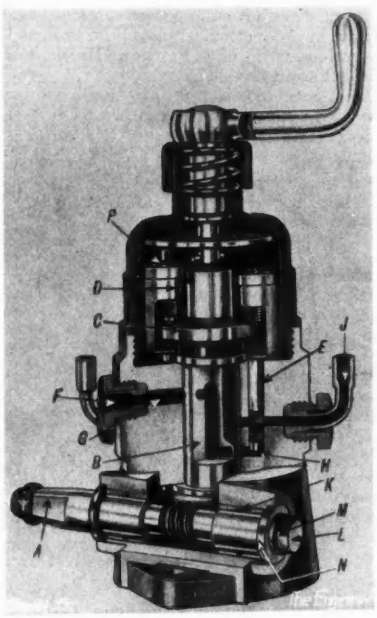
London Generation.—We have received a copy of the first issue of "London Generation," the journal of the London Division, British Electricity Authority. As stated in a foreword by Mr. J. N. Waite, the Divisional Controller, the aim of the journal is to enable all employees in the division to keep in touch with its activities and to maintain an interest in the educational and recreational facilities now being organised. "London Generation" is published bi-monthly from Ergon House, Horseferry Road, London, S.W.1, whence future issues can be obtained at 3d. per copy.

A Mechanical Pressure Lubricator

RECENTLY we received particulars of a mechanical pressure lubricator, now manufactured by C.A.V., Ltd., Acton, London, W.3, which has been designed for incorporation in a variety of mechanical plant, particularly machine tools, small compressors, pumps and engines.

As shown in the accompanying illustrations, the lubricator, known as type BMRD, is a compact pump, which is designed to give up to six independently adjustable feeds. It is equally efficient whichever the direction of rotation of the driving shaft, and it is, therefore, particularly suitable for reversing engines or mechanisms. Alternatives in the internal gearing are offered to suit a wide range of operating speeds. The complete unit weighs about 3½lb. When the plungers are adjusted for maximum stroke and the distributor shaft is rotated at 20 r.p.m., the total delivery, against a pressure of 150lb per square inch, is 0·06 c.c. per stroke, or 72 c.c. per hour.

The general construction is shown in the sectional views reproduced herewith. A barrel distributor shaft, mounted vertically and centrally in the pump body, is rotated through a pinion at its lower end and a worm on the driving shaft. It is desirable that the speed of the distributor shaft should not exceed 20 r.p.m.,



SECTIONAL ARRANGEMENT OF LUBRICATOR

but standard gear ratios for the worm reduction are available, with ratios of 12½, 25 and 50 to 1, to suit driving shaft speeds up to 250 r.p.m., from 250 to 500 r.p.m., and from 500 to 1000 r.p.m. respectively.

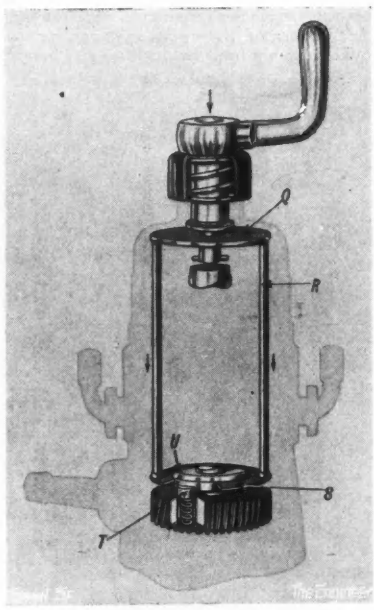
Spaced equally round the distributor shaft are six plungers operated by a face cam mounted on its upper end. Each plunger is provided with a guide and adjusting screw to vary the effective working stroke. The face cam and adjusting screws are enclosed by a metal cover screwed into the top of the pump body. This cover carries a spring-loaded priming handle, permitting the distributor shaft to be turned by hand independently of the driving shaft, as described later.

Operation of Lubricator

When the driving shaft *A* is rotated, the worm gear turns the barrel shaft *B* to which is attached the face cam *C*. The lip of the cam fits into guides *D* of the plungers *E* and, as it rotates, imparts a reciprocating movement to each plunger, which forces oil to its feed point. Oil from an external container enters the pump body through the inlet connection *F*. The oil then flows through the suction port *G* and into the barrel distributor shaft, through one of six upper radial holes.

Considering one plunger and its associated oil flow, during the upward or suction stroke of the plunger there is direct communication between the interior of the barrel shaft and the space at the bottom of the plunger via the barrel shaft lower radial hole and lower plunger port *H*. As the plunger ascends oil is drawn into the space below it and is trapped there at the completion of the stroke, as the barrel shaft has then turned and closed the port.

On the return or pressure stroke, the oil previously trapped is forced back through the lower plunger port along a discharge channel



HAND PRIMING DEVICE

in the shaft which is now opposite port *H*, through the upper plunger port and hole in plunger into the oil outlet connection *J* and thence by piping to the feed point.

The drive shaft is reversible by removing plugs securing the bearing bushes *K* to the body and withdrawing them. After screw *L*, spring washer *M*, and securing ring *N* have been removed, the driving shaft can be withdrawn from the housing.

The rate of delivery from each element of the lubricator may be varied by means of the plunger adjusting screw *P* which controls the effective stroke of the plunger. Turning this screw anti-clockwise increases the output; turning it clockwise reduces the output; zero output is reached if the screw is disengaged entirely from the face cam. The adjusting screw is securely locked by a spring clip so that the setting will not vary in service.

If one of the pump outlets is not required, the adjusting screw of the corresponding plunger is turned clockwise until the oil flow is completely cut off. On no account should the oil outlet be plugged up, for should the adjusting screw be accidently moved, thus bringing the plunger again into operation, the pressure exerted by the plunger would damage the pump.

Hand Priming.—It will frequently be found desirable to fill the piping with oil before starting up or to increase the amount of oil delivered to the feed points temporarily during running. A hand priming device is provided for this purpose.

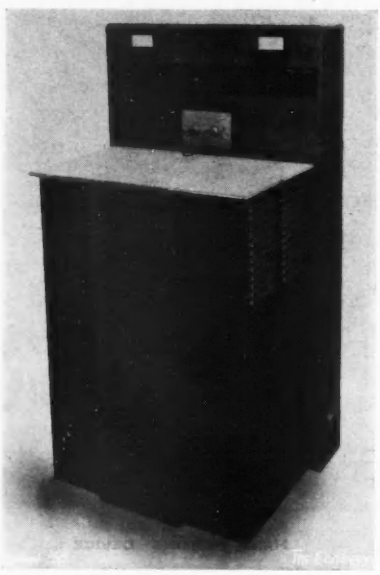
When the priming handle is depressed, a pin

at the lower end of the shaft engages with the barrel shaft, as shown in our second illustration; the lever also depresses a plate *Q* and clutch rods *R*; these rods push down a lower plate *S*, which in turn compresses two spring-loaded driving pegs *T* out of engagement with worm wheel bush *U*, which is keyed to the shaft. The barrel shaft is then free to rotate independently of the worm wheel. The pump may now be hand operated by turning the depressed priming handle.

A 2·5-kW Radio-Frequency Heating Equipment

We have received details of a compact form of high-frequency generator, designed and manufactured by Philips Electrical, Ltd., Century House, Shaftesbury Avenue, London, W.C.2, for the heat treatment of small parts. With a continuously rated output of 2·5kW at the terminals, the generator is suitable for accurate repetition brazing, soft and hard soldering, spot heating, local hardening and tempering.

As illustrated herewith, the generator is provided with a built-in work-table. The table-top is made of Sindanyo sheet, which is heat-resistant; the working plane is 42in above the ground and a few inches below the output terminals, which are shown in the illustration, fitted with a typical work coil. For certain applications (for example, on a mass-production belt) this work-table arrangement would be unsuitable; provision is therefore made for alternative outlet terminals at the side of the generator.



RADIO-FREQUENCY GENERATOR

To achieve maximum flexibility the set incorporates a six-position matching control switch for adjusting the generator to the work. By making use of this control switch full power can be applied to a wide range of jobs without requiring laborious work coil design. A similar knob on the right of the control panel, in association with the central horizontal scale, provides smooth control of power from 50 per cent to 100 per cent. There are two meters on the panel to indicate valve input current and generator output current respectively. In the space between the two meters are the generator "on-off" switch and a "high-low" power switch. A foot switch attached to a length of cable controls the h.f. power.

Two removable panels provide access to all the components for servicing purposes, and interlocks are included to ensure that removal of either panel causes voltage to be taken off the set. All circuits and components are protected by h.r.c. fuses and there is a hand reset overload trip to protect the equipment from abuse. The power consumption of the generator is specified as 5kVA at 0·85 power factor, when operating on a single-phase 200–250-V supply.

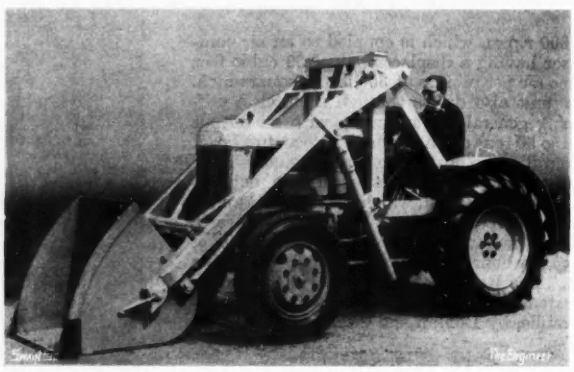
The equipment is 60in high by 33in wide by 28½in deep and is mounted on castors to allow it to be moved easily from one work position to another.

Some examples, quoted by the manufacturers of the generator, to illustrate its performance, may be of interest. It is stated, for instance, that, in hardening the pads of valve rocker levers (0·5 per cent C steel) for automobile engines, a hardness of 700 V.P.N. (30kg) was obtained to a depth of 0·1in in 6 seconds, with an input power of 4kW. In another typical application, the local hardening of 35mm film sprockets, a hardness of 800 V.P.N. was produced in 4 seconds, using the full generator output. An important consideration in this particular job was the necessity for avoiding distortion of the bore and the actual deformation is stated to have been less than 0·0001in.

A Hydraulically Operated Loading Shovel

We illustrate below a hydraulically controlled loading shovel of ⅞ cubic yard capacity, which has been developed by W. E. Bray and Co., Ltd., St. John's Road, Isleworth, Middlesex, and is now in production. It has been designed for operation with the Fordson Major tractor and is known as the "Hydraloader."

The machine is robustly and compactly designed; the main frames are all of welded construction and are triangulated to withstand loading shocks. The main boom consists of two welded box sections with a cross-tube bracing to assist the twisting strains imposed by a full bucket. The construction has been modified slightly since the photograph which we reproduce was taken, and the bottom booms now extend from the front to the rear axles so that loading stresses are not transmitted through the tractor itself. A secondary push-beam has been incorporated to effect a "crowding action" on the bucket, which is tipped progressively rearward during the lifting motion. In this manner a full bucket is obtained more quickly and inspillage reduced when the machine is travelling. The maximum delivery height to the underside of the tipped bucket is 10ft 3in, this height being reached from ground level in six seconds.



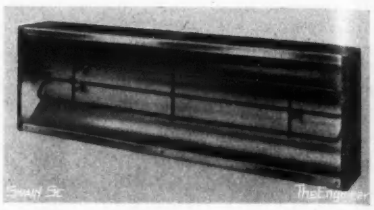
HYDRAULICALLY OPERATED LOADING SHOVEL

The bucket is actuated by hydraulic jacks, which are of the displacement type and are hard chromed to give resistance against abrasion. The pump which supplies pressure to these jacks is directly driven and runs at engine speed. The hydraulic oil is continuously filtered, and a safety valve is incorporated to protect the hydraulic system from overload. The reservoir tank forms the driver's seat.

Electric starting equipment is fitted on all models for use in Great Britain, but the engine may also be started by hand through the pump. The front tyres are 34 × 7 eight-ply heavy-duty type, and 12·00 × 24 eight-ply earth-mover rear tyres are fitted. The overall length of the machine is 15ft, its width 6ft 8in, its height 7ft, with the bucket down; its operating weight is about 4½ tons. Ancillary equipment which may be fitted includes a bulldozer blade, a crane attachment and an operator's cab.

Infra-Red Element Projector Units

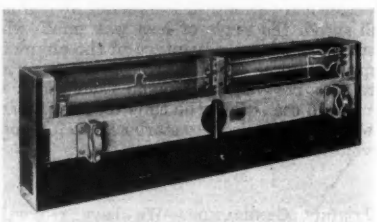
The recently introduced range of infra-red element projector units forms a useful addition to the industrial infra-red equipments manufactured by Metropolitan-Vickers Electrical Company, Ltd., Lamp and Lighting Department, 132-135 Long Acre, London, W.C.2. Fitted with the company's well-known tubular sheathed heating elements, the projector units are suitable for such general infra-red heating applications as paint stoving, print drying, moisture extraction and pre-heating. In addition, the equipments can be used for special processes including, for example, the curing of poly-vinyl-chloride in sheet form, which requires high intensity units with a rating of about 2kW per square foot.



PROJECTOR UNIT

In its standard form the projector unit is 11 $\frac{9}{16}$in wide and is available in alternative lengths of 36in, 24in and 18in. Each standard projector incorporates three heating elements and various projector loadings are available, as follows: 2kW for the 18in unit; 2kW and 2·7kW for the 24in unit; and 3kW and 4kW for the 36in unit.

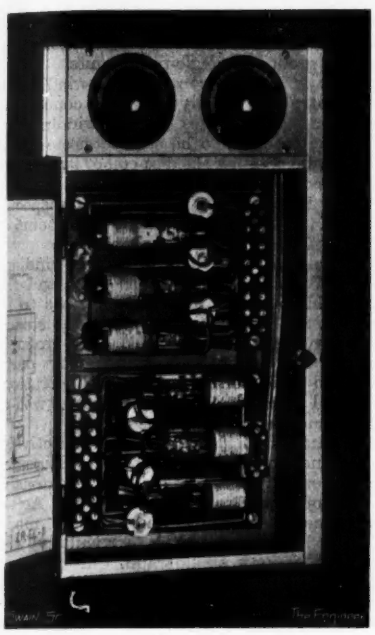
Flexibility in operation is a characteristic of these projectors, since the units, as illustrated herewith, are capable of being used singly, or mounted end-to-end to form continuous troughing, or butted side-by-side to form a bank, or mounted in a suitably contoured framework to form a complete oven. For special purposes projectors can be supplied in non-standard lengths, with higher or lower intensities of radiation, and with more or



PROJECTOR UNIT SHOWING WIRING

fewer elements than the three provided in the normal assembly.

Two views of a typical projector are reproduced herewith to show the general construction. Each element consists of fine grade nickel-chromium wire tightly embedded, by a special process, in magnesium oxide to form a solid cylindrical mass completely enclosed in an outer sheath of non-scaling, non-corrodible alloy in the form of $\frac{5}{16}$in or $\frac{3}{8}$in dia. tube. This construction ensures that the spiral is held immovably in the middle of the bore with a uniform thickness of insulation separating it from the sheath. In operation, the average temperature is from 700 to 750 deg. Cent. The element has a peak radiation with a broad band



CONTROL PANEL FOR PROJECTOR UNIT

at 27,000AU, and an extension beyond 40,000AU which, in an infra-red lamp is the glass "cut-off" point.

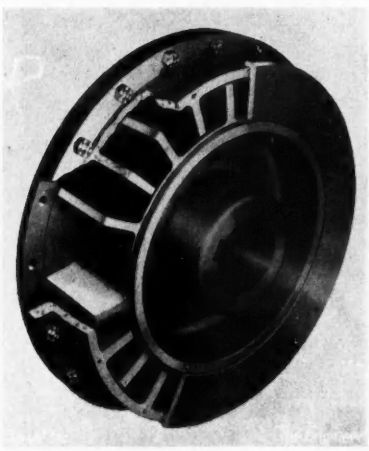
Behind the element assembly is a parabolic reflector of "Brytal" anodised aluminium, mounted in a substantial frame fitted with detachable outer covers. As shown in one of the photographs reproduced herewith, there is a wiring channel at the back of the reflector, and provision is made for $\frac{3}{4}$in conduit entry. Two support clamps are fitted to the back of each projector to take 1in dia. bar or tube. Projectors are available for d.c. operation or single phase or three phase a.c.

A special range of control cubicles has been designed for use with these heating element projectors to allow the energy input and, therefore, the element temperature and the radiation intensity to be varied from 0 to 100 per cent. of rated load. The control equipment consists essentially of a suitable arrangement of hot-wire vacuum-switch relays operated by an energy regulator working on the principle of a bi-metallic strip. As illustrated herewith, the typical control panel carrying the necessary regulator dials forms a compact and convenient means of controlling the temperature of the projector. Push buttons can be incorporated for the remote control of an installation.

The "Holset" Coupling

A photograph we reproduce herewith shows a new flexible heavy duty coupling which has been introduced by W. C. Holmes and Co., Ltd., of Huddersfield. This coupling is known under the trade name of "Holset," and has a very wide range of industrial application.

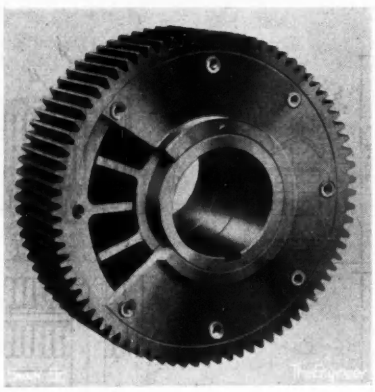
The coupling is of particularly simple construction, and uses rubber blocks in compression as force transmitting elements between blades in the driving and driven members. It has only five principal parts. A driving disc is attached by bolts round its outer circumference to the back of the driving member. A series of projecting blades are formed on the inner circumference of the driving member, and in cavities between these blades and corresponding blades of a driven member,



FLEXIBLE RUBBER BLOCK COUPLING

pairs of rubber blocks are inserted. The assembly is completed by an annular ring cover plate, which is attached by screws to the rim of the driving member.

The pairs of rubber blocks, which vary in number according to the size of the coupling, are initially compressed at the works when being inserted into the cavities between the blades of the driving and driven members. This initial compression is designed to prevent the complete unloading of any rubber block under severe torque conditions. The makers point out that each block is allowed free space



RESILIENT GEAR

to deform, and only when a coupling is grossly overloaded would the cavity be completely filled. This arrangement ensures that the full resilient properties of the coupling are utilised.

The blades of the driving and driven members have a large area and the blocks of rubber are uniformly stressed and are not subject to the high specific loads which would result from small areas of contact. The driving and driven members and rubber blocks remain integral when the coupling is disconnected by removal of the driving disc bolts.

A new range of resilient gears introduced by the firm is of similar construction to the couplings, except that the driven members have gear teeth machined round their outer circumferences. The design of one of the new gears can clearly be seen in the second photograph we reproduce.

Power Transformers for Systems Operating at 200-kV and Above*

To date orders have been placed in Great Britain for systems abroad operating at 200kV and above, for over 1,000,000 kVA of power transformers, as follows:—

Number of three-phase groups of single-phase units	Twelve
Number of three-phase units	Six
Total number of installations	Eighteen
Corresponding rated kVA	1,187,000

It is not generally known what a large aggregate MVA capacity these units comprise, probably because all of them are for systems abroad; but, in fact, they constitute one of the electrical industry's major contributions to this country's export target. A few particulars of some of these units may therefore be of interest to operating engineers in general before reviewing the trend of purchasers' inquiries and of makers' designs.

Three-Phase, 64-MVA Units for Finland

These units have been designed to use common parts and be the same as far as the purchasers' requirements will permit. They are designed for test pressures in accordance with the Swedish Specification SEN. 30, i.e., the h.v. windings are suitable for an impulse test level full wave of 1200kV, using a 1+50 microsecond wave and a power frequency test of 530kV for one minute. The windings are in addition fully insulated throughout.

The transport difficulties for these transformers are considerable, since, although the railway loading gauge in Finland is even bigger than the European International, the largest available railway truck limits the transport weight to 90 tons. This has necessitated the use of a special transport tank, and in consequence drying out will be necessary on site.

The combination of impedance and low weight required for these units has led to a double concentric winding arrangement. The 220-kV or 230-kV winding is arranged in between the inner and outer sections of the 115-kV or 110-kV winding.

Two of the units are being provided at the neutral ends of the 110-kV winding with on-load tap-changing equipment having a range of ±15 per cent.

The two other units are being provided with off-circuit tapping switches in the 115-kV winding. The arrangement of these units is shown in Fig. 1, which is a photograph of a scale model which was made to show more clearly than a drawing how the transformer and its cooling banks could be accommodated in the restricted space which is available on the site. The transformers are designed to be installed in the space between the towers of the 230-kV line and maintain clearances in accordance with the Swedish Standard Specification SEN. 30.

The windings are designed so that the magnetising force axially along the core leg is balanced between the h.v. and l.v. windings to minimise electromagnetic forces. Tappings are arranged in layered windings so that, in spite of the large range of 30 per cent, this electro-magnetic balance is maintained whichever tapping is in use.

The type of cooler adopted for the ON/OFB rating follows well-established British practice, being similar to that supplied with some several million kVA of transformers for the C.E.B.

In these particular units the forced oil circulation is internally directed through the windings so that each section gets the required proportion of the total oil flow. This control of the oil circulation ensures that the temperature of each part of the winding is accurately fixed.

Both the 115-kV and 230-kV windings on these transformers are designed so that the insulation between turns and between sections is uniformly stressed throughout the winding under surge conditions. As a check on the

* Abstract. Paper prepared by transformer makers of the British Electrical and Allied Manufacturers' Association and presented on their behalf by H. S. Holbrook at the British Electrical Power Convention June 16, 1949.

calculated surge distribution, completed coil stacks are tested with the recurrent-surge oscillograph before assembly on the core is complete. This control of the stresses in the design is especially important on transformers of this type with two high-voltage windings, as it eliminates both dangerous weak spots and wasteful "strong spots," where the local strength is lower or higher than the general level.

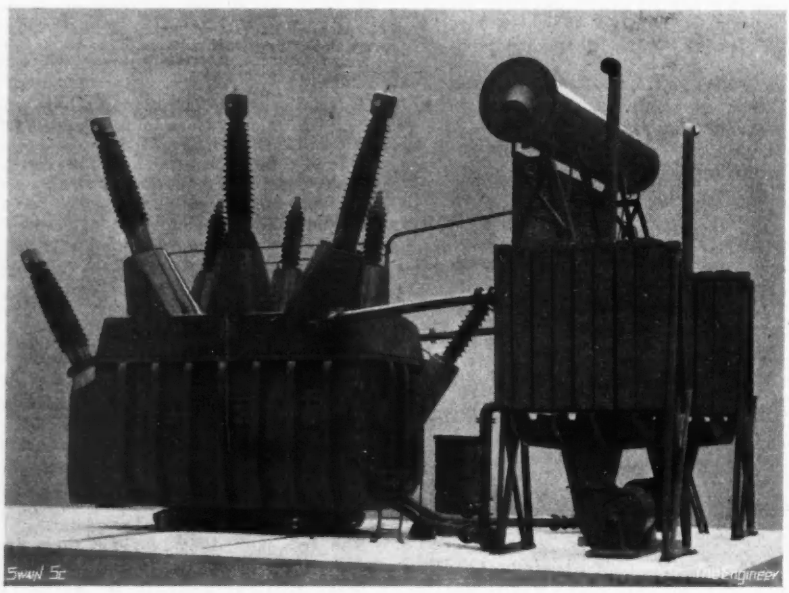


FIG. 1—*Scale Model of 64-MVA, 230-kV Three-Phase Transformer*

Another Design of 64-MVA Unit for Finland

This design is particularly interesting, as it provides an example of high-voltage on-load tap-changing gear of the mid-point reactor type. The transformer is a three-phase, 64-MVA unit with three windings. The h.v. winding is rated at 225kV and is designed for an impulse test level of 1250kV, using a full-wave of 1+50 microsecond shape and for a one-minute test at 530kV. The m.v. winding is rated at 112·5kV and is designed for an impulse test level of 650kV full-wave and for a one-minute test at 275kV. The l.v. winding is rated at 10·5kV and at one-half of the kVA rating of the other windings. All windings are fully insulated throughout.

The general arrangement of this transformer is shown in Fig. 2.

The windings are concentrically arranged, with the 10·5-kV windings next to the core and the 225-kV winding on the outside. Between these windings is arranged the 112·5-kV winding, and in this are provided tappings giving a range of ±15 per cent in twelve steps. These tappings are arranged in a separate coil of the full-limb length, which is so designed that each tap section has equal axial length to ensure that whichever tapping is in use there is a balance of the mechanical stresses which are set up by any line faults external to the transformers.

A general view of the on-load tap-changing gear is given in Fig. 4. The 112-kV winding being fully insulated, the on-load tap-changing gear is also suitable for the one-minute test of 275kV. It is believed that this is the highest test voltage for which on-load tap-changing gear of the mid-point auto-reactor type has yet been built.

For transformers of these high voltages the drying and complete oil impregnation of the insulation is of the first importance. The oil impregnation during manufacture is accomplished whilst the insulation is under vacuum, and with such large and heavy apparatus this has called for the development of special manufacturing equipment and corresponding technique.

Design Trends

The diverse requirements of purchasers has naturally resulted in diverse designs. There is no one design which is the best for all installations.

Transport limitations result, for the highest voltages and the largest outputs, in a tendency to adopt groups of single-phase units.

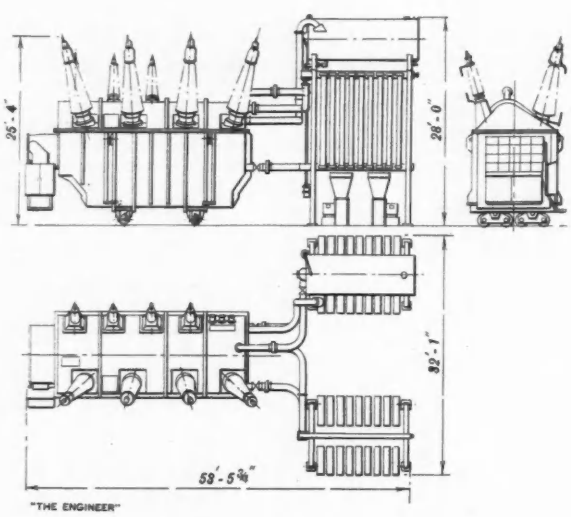
Whatever the core construction, windings in this country are usually arranged concentrically. For these voltages the h.v. windings are invariably specified to be star connected, and they may be of either the disc-coil or layer type. The decision on which to use a particular order is largely influenced by the purchasers' specification of the insulation at the neutral point of the winding.

The major insulation between the windings and from each of them to the core, and the internal insulation of each winding, has to be designed, not only with respect to the steady working voltage, but also to withstand probable transient voltages. Such surges may occur owing to the normal switching operations associated with large blocks of power as well as under atmospheric disturbances.

All makers, both individually and collectively, in conjunction with the Electrical Research Association, have made detailed and extensive studies of the problems involved. Actual transformer assemblies and special model windings have been tested, particularly with the recurrent-surge oscillograph.

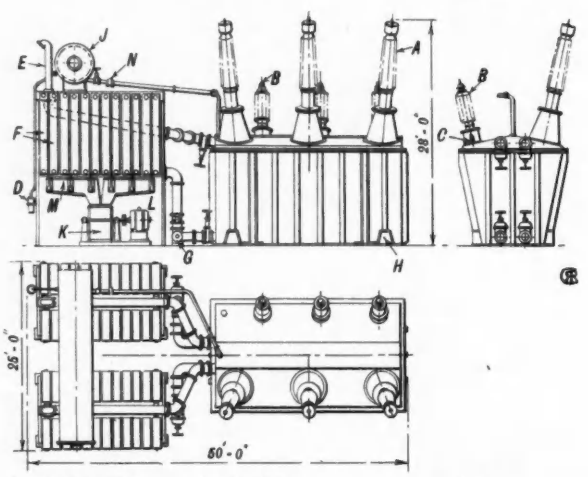
These studies enable the intersection voltages in a disc-coil winding to be estimated and designs to be prepared suitable for impulse test without such thick turn and section insulation that the thermal characteristics would be prejudiced. Such a disc-coil winding is shown in Fig. 6.

The multi-layer type of h.v. winding has been employed in this country with success on testing transformers up to and including 1000kV for many years, and several transformer makers are studying its application to power transformer h.v. windings when the neutral is solidly connected direct to the transformer tank.



Shipped weight without oil... ... ... 90 tons
Total weight with oil and cooling gear ... 240 tons

FIG. 2—*General Arrangement of Three-Phase Transformer with Reactor Type On-Load Tap-Changing Gear*



A	275-kV bushings.	*F*	Radiators.	*K*	Fan.
B	132-kV bushings.	*G*	Oil-immersed pump and motor.	*L*	Fan motor.
C	Neutral bushing.	*H*	Jacking lugs.	*M*	Air ducting.
D	Breather.	*J*	Conservator.	*N*	Bucholz relay.
E	Emergency release.				

Approximate Weights
Complete with cooling gear and oil ... 250–300 tons
Arranged for transport ... ... 140–160 tons

FIG. 3—*Outline General Arrangement of Auto-Transformer, 300-kV Class*

This construction effects a grading of voltage between layers not unlike that obtained in condenser bushings, since the evenly spaced concentric layers are enclosed by an electrostatic shield on the outside connected to the line terminal, and a corresponding inner shield is provided by the l.v. winding. Impulse voltages applied to such a winding are distributed throughout it, substantially linearly.

Designs for high voltage and large power tend to have a large impedance. The multi-layer arrangement results in a reduction in the effective spacing between windings with a consequent reduction in impedance, for which a relatively low value is often stipulated from considerations of operating stability of a transmission scheme.

Long thin windings, as applied in the past, have usually been regarded as inherently weak mechanically to withstand axial forces resulting from conditions set up by external short circuits under line faults, but tests on modern constructions have shown these to be satisfactory.

Every turn is in direct contact with the cooling oil in a vertical duct between layers. Oil circulation by natural convection due to thermal head would suffice in many instances, but the design facilitates forced circulation of oil through the vertical ducts by the provision of suitable deflectors.

Transformers for the 300-kV and 400-kV Classes

The transmission of power over long distances is associated with high transmission voltages.

At operating voltages in the 300-kV and 400-kV classes, to be economical the circuit ratings will be large, and economics will also demand the largest transformer units which can be transported. To ease transport the radiators, bushings and other external fittings would be removed; also the units would be transported without oil.

The low-voltage side of such transformers is likely to be associated with a network rather than directly with generators in view of the magnitude of the current and connections which would otherwise be involved. If that network is operated like the British grid with every transformer winding connected to it earthed solid to its tank, then auto-transformer connection is permissible.

Forced oil cooling is probable at rated output, with thermo-siphon cooling only sufficient for the excitation losses at no load.

With the assistance of the Ministry of Transport it is possible that in the 300-kV class an auto-transformer of turns ratio 145/290 and without tappings, and built as a three-phase unit and generally arranged as Fig. 3, could be transported and rated at 240MVA.

If it was desired to employ single-pole automatic opening and reclosing of the circuit breakers, then single-phase units would be necessary and a group of such could be rated at 300kVA.

In the 400-kV class only single-phase units are proposed, and a group of auto-transformers of turns ratio 145/380 and generally arranged as Fig. 5 could be rated at 300MVA.

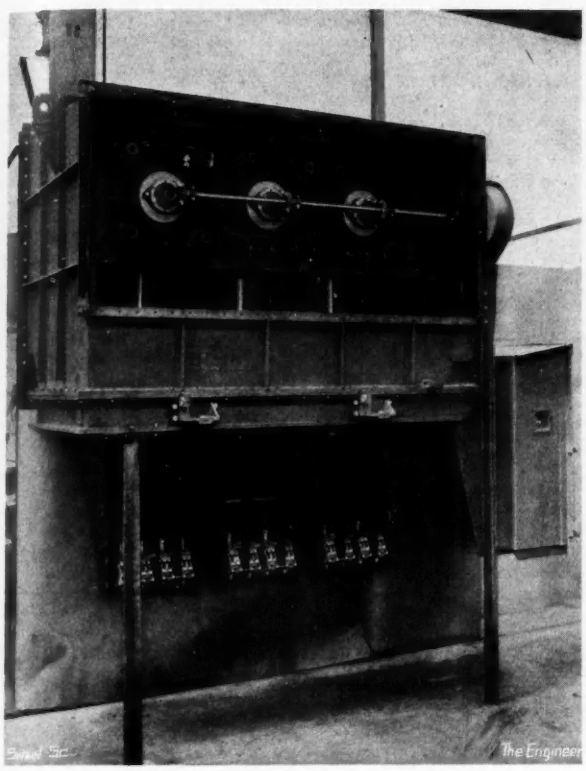


FIG. 4—*Reactor Type On-Load Tap Changing Gear for Fully Insulated 112-kV Winding*

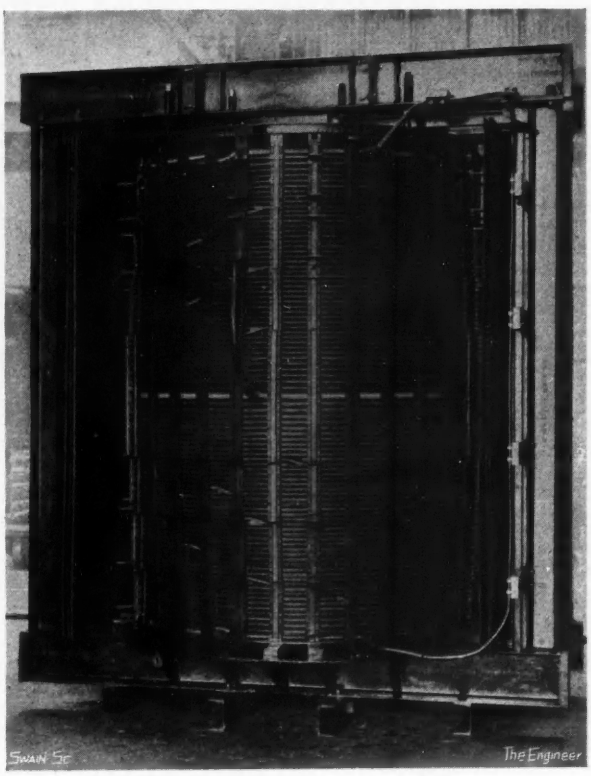
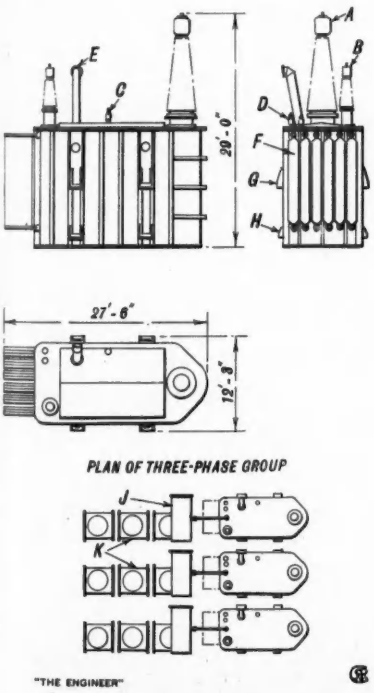


FIG. 6—*Prototype Single-Phase Unit for a 90-MVA, 264-kV Group*



A	400-kV bushing.	*F*	Radiators.
B	145-kV bushing.	*G*	Transport lugs.
C	Neutral bushing.	*H*	Jacking lugs.
D	Tertiary bushings.	*J*	Conservator.
E	Relief pipe.	*K*	Air-blast coolers.

Approximate Weights

Each single-phase unit.

Complete with oil	180 tons
Arranged for transport	125 tons

FIG 5.—*Auto-Transformer, 400-kV Class, Outline General Arrangement*

Electrification of a Bengal Jute Mill.—An order has been received by the General Electric Company, Ltd., for the complete electrification of Bansberia Jute Mill No. 1, which is on the bank of the Hooghli River, near Calcutta, and is owned by the Ganges Manufacturing Company, Ltd. Since 1926, when production first began, the mill machinery has been driven by a steam turbine, which is now to be replaced by 3·3-kV electric motors. In the new scheme, the incoming 6·6-kV, 3-phase supply terminates in the mill sub-station at a seven-panel S.V.D. switchboard of 150-MVA breaking capacity for controlling the supply to four main step-down transformers. The largest of the transformers is rated at 1500kVA and provides a 3·3-kV supply to the main mill motors; three 550-kVA transformers provide a 420-V supply for the auxiliary drives. The 3·3-kV supply to the mill motors is controlled by a twelve-panel S.V.D. switchboard of 100-MVA breaking capacity, and two industrial-type oil-immersed switchboards control the 420-V auxiliary supplies. The main groups of machines in the various sections of the mill will be driven by ten 3·3-kV induction motors totalling 1850 h.p. In the use of all-electric drive, No. 1 mill follows the example of Bansberia Jute Mill No. 2, which was built in 1929, and was completely electrified by the G.E.C.

Industrial and Labour Notes

Employment and Unemployment

The monthly employment statistics issued by the Ministry of Labour show that the working population of Great Britain remained virtually unchanged during May, and at the end of that month totalled 23,209,000. The number of people in civil employment, however, increased during May by 37,000 (9000 men and 28,000 women) and by the end of the month totalled 22,136,000.

Of that total, 4,248,000 were employed in the basic industries of the country, a net increase of 6000 compared with April. The increase was taken, however, by the gas, electricity and water industries and by transport and communication, and the Ministry reports a decline of 3000 during the month in coal-mining, the total strength being given as 785,000. Total employment in the manufacturing industries was increased in May by 8000 to 8,257,000. The principal increases in this group were in the clothing, food, drink and tobacco industries. In the metals, engineering and vehicle industries manpower was reduced by 6000 to 3,912,000, and thus continued the downward trend which began at the end of last year.

Unemployment figures which accompany the statistics relate to June 13th, on which date 263,643 people were registered as out of work, compared with 304,165 on May 9th. The June 13th total includes 194,447 men of eighteen and over, of whom 4936 were temporarily stopped.

Engineering Exports to Canada

Both the United Kingdom Engineering Mission, led by Sir Henry Gilpin, and the President of the Board of Trade have lately expressed the conviction that Canada, despite its relatively small population, will become increasingly important as a purchaser of capital goods. But it has also been emphasised that United Kingdom manufacturers can expect to make headway in this highly competitive market only by studying its requirements carefully and by maintaining a highly efficient sales and servicing organisation.

The Board of Trade has now announced that a section of the British engineering industry is to make a determined effort to extend its share of the Canadian market, at present amounting to less than 10 per cent in particular categories. To that end a Canada Exhibition Committee has been formed by the Machine Tool Trades Association, the Gauge and Tool Makers' Association, the Scientific Instrument Manufacturers' Association, the Federation of British Hand Tool Manufacturers, the Portable Electric Tool Manufacturers' Association, the British Compressed Air Society and the National Federation of Engineers' Tool Manufacturers, and its intention is to plan a comprehensive display of production and research at the third Canadian International Trade Fair, to be held in June, 1950. This display, which will be known as the British Tool, Machine Tool and Scientific Instrument Section of the Fair, is expected to require about 35,000 square feet of stand space, and will be housed in Toronto.

Mr. W. J. Morgan is the secretary of the Canada Exhibition Committee, which at present has its headquarters at the offices of the Machine Tool Trades Association, Victoria House, Southampton Row, London, W.C.1.

The Economic Situation

Opening a debate on the economic situation in the House of Commons on Thursday of last week, the Chancellor of the Exchequer, Sir Stafford Cripps, said that, put in its simplest form, the sterling area was currently running a deficit with the dollar area of £600,000,000 sterling a year, or one and a half times the total of its gold reserves. No one, he observed, would doubt that that condition of affairs must be altered. Giving a more detailed explanation of the figures which he presented, the Chancellor mentioned among other matters that in the first six months of this year this country's dollar exports were £12,000,000 less than had been expected. That, he said, was mainly the result of the falling-off in trade with the U.S.A. over the last three months. Trade with Canada had kept up better, though he believed that still further efforts were needed and would be made in that vital market.

Later in his speech, Sir Stafford dealt with what he called the short-term expedients for dealing with the situation. Whilst all existing contracts and commitments would be honoured, a "standstill" was to be imposed on the importation of certain goods. Any interference with imports of machinery, he said, was obviously undesirable, as the best possible re-equipment for industry was wanted. But the raw materials to run existing industrial capacity must come first, so that as things were this country could not afford the considerable quantities of dollar machinery which it had been importing. As to raw materials themselves, steps must be taken to see that necessary cuts did the least possible damage to our productive effort. Sir Stafford went on to say that no question of any general shortage of raw materials should arise, as from all sources it was expected to import substantially more than in 1948, even after making the new cuts. On the assumption upon which the Government was provisionally working, there should be enough raw materials to sustain the present overall level of production.

Cuts would be necessary, however, in the imports of all the important dollar materials and Sir Stafford stated that those principally affected would be timber, paper and pulp, non-ferrous metals, steel and cotton. In the case of non-ferrous metals, the cut in dollar expenditure would amount to about 25 per cent, but because of changes in sources of supply and price alterations it was expected that it would be possible for consumption to be maintained at about the existing level. As regards steel, the Chancellor commented, a part of our imports would have to be cut off so that the maintenance of a high level of home production became more important than ever.

Finally, the Chancellor spoke of "other elements of high costs in our production," particularly in some of our older industries, elements which, he said, were within the control of managements and workers. He emphasised once more—as he admitted he had so often done in the past—the need for production methods to be brought and kept up to date and at the highest point of efficiency if our industries were to remain fully competitive in world markets. That, Sir Stafford observed, did not mean that all our prices were at present too high or that all our methods were old-fashioned. But it was necessary to examine those particular sectors of industry which showed themselves uncompetitive through high costs, and to see where and how their efficiency could be improved. There was a positive and pressing duty upon all engaged in such industries, whether managers or workers, to put into operation methods which could improve their productivity.

The Dock Strike

At the time of going to Press the docks dispute continues and more than 15,000 men are absent from the London docks. Some 9000 troops, called in by the Port Emergency Committee for London, were at work on Wednesday last, reducing considerably the number of idle ships.

A statement issued on Tuesday night by the National Dock Labour Board, ordering all dockers on strike to return to work by Thursday morning, and implying that the national dock labour scheme would be in jeopardy if they did not do so, was repudiated five hours later by the Government, from 10, Downing Street, on the grounds that the notice was issued without the authority of the Emergency Committee. The Government stated that it was entirely in agreement with the Board that all men should return to work at the earliest possible moment, but thought it right to state that no step was contemplated to bring the national dock labour scheme to an end.

Lead Price Increase

At the beginning of last week the Ministry of Supply announced reductions in the prices of copper, lead and zinc, to bring them into line with current prices in the U.S.A. Later in the week the Ministry stated that owing to a rise in the price of lead on the American market, the British price of good soft pig lead had been increased, as from July 14th to £81. Discounts and premiums remain unchanged, and the additional charges now made on orders booked for delivery subsequent to the month of order are also unchanged.

A.C. and D.C. Motor Prices

A statement issued by the members of the Associated Dynamo and Motor Manufacturers indicates that, in pursuance of the policy of supporting the Government in stabilising prices, no increases in the prices of a.c. and d.c. motors are to be made, despite the considerable rises in costs of labour and materials which have taken place since the last general increases in prices at the beginning of 1947. Figures of these increased costs are given, including: ferrous metals, 19 per cent; electrical sheet steel, 14 per cent; copper, 0·5 per cent; aluminium, 24 per cent; tin, 49 per cent; lead and insulating materials, 17 per cent, and labour, 6 per cent. In addition, it is noted that the costs of common services have increased during this period.

Maintenance of prices at current levels, the statement continues, is possible principally because of increased output coupled with improved methods of production and increased availability of raw materials.

Coal Board Profit

Speaking at Dover on Saturday, Lord Hyndley, chairman of the National Coal Board, mentioned that the figures for the financial results for the first quarter of this year would probably be published soon. He expected them to show a considerable improvement on last year, with an average profit in Britain amounting to something over 1s. per ton.

But the improvement in output, Lord Hyndley continued, was less satisfactory. Production of deep-mined coal during the first half of the year was better than that of the corresponding period of 1948 by about 2,700,000 tons. He felt that a further improvement could and would have to be made. To get 207 million tons, which he considered to be the absolute minimum, 4,300,000 tons would have to be averaged a working week in the second half of this year. Though he was well aware that there were holidays to take into account, he drew attention to the low production figure for the previous week—3,762,000 tons.

The Railway Wages Dispute

On Tuesday night the Ministry of Labour announced the names of the members of the Board of Conciliation being set up to try to help the Railway Executive and the railway unions to solve the wages dispute between the Executive and the National Union of Railwaymen. They are Sir John Forster, K.C. (chairman), Sir Harold Barton, Mr. Charles Murdoch, Mr. A. J. Espley, and Mr. John Brown. Sir John Forster has been President of the Industrial Court since 1946.

There has been some delay in this announcement because of difficulties raised first by the Confederation of Shipbuilding and Engineering Unions, and later by the National Union of Railwaymen about the terms of reference. Since agreement could not be reached the railway shopmen are now excluded from the consideration of the Board and the Confederation will not be a party to the discussions.

French Engineering News

(From our French Correspondent)

A recent "Road Week," held at Lille, was organised as a protest against the poor condition of regional highways and negligence of the public authorities. Monsieur Dehedin, Director of the Automobile Club du Nord, stated that the Nord was very poorly treated in highway plans, although in the Lille-Roubaix-Tourcoing agglomeration (a radius of 12km, with over a million inhabitants) over 45,000 vehicles circulated compared with 35,000 at Marseilles and 30,000 at Lyon. Immediate broadening of certain highways and other improvements were demanded.

* * *

Monsieur Laffon, President of the Nord and Pas de Calais Mines administrative council, has declared that the improved quality of coal should lead to an appreciable reduction in the price per calorie. Production in the Lorraine basin is planned to reach 12,300,000 tons in 1952, and, according to Monsieur Laffon, increased productivity will enable competition to be met. By 1952 the total coal production is planned to be washed.

* * *

An inquiry on absenteeism undertaken by the French Ministry of Labour shows a considerable variation in the course of the week according to professional groups and sexes. The proportion is highest on Mondays and Saturdays, and absenteeism among women is higher than for men. Since 1946, however, it has been distinctly reduced. Absenteeism is particularly marked where work is hardest, as in ore extraction, glasswork and ceramics. On the other hand, it is very low in industries menaced by unemployment.

* * *

Steel production showed an increase in May, and figures for cast iron were the highest of any of the first five months of the year. March still marks the maximum for steel. The increase in cast iron production was not expected, considering the fairly small demand, but can be considered to be due to technical reorganisation of blast-furnaces. Average daily production in May of cast iron and crude steel for France and the Saar was 28,900 tons of cast iron and 38,600 tons of crude steel, against 27,700 tons and 35,600 tons respectively in April. Production now having reached the level of needs, measures are being taken to reduce June production to meet the reduced internal demand, which is estimated at 20 per cent less than for May. Exports will partly offset this drop, however. France is supplying 210,000 tons of iron and steel to Switzerland annually, 40,000 tons of steel to Jugoslavia, 200 million francs worth of rails to Spain, 10,000 tons of steel products to Portugal, 60,000 tons of steel products and 30,000 tons of cast iron to Italy, and 76,000 tons of steel products to Finland. An agreement has been signed with Norway and negotiations with Sweden are taking place. It is hoped that some arrangement with Germany will be made to bring the prices of German and French steel into line. France is hoping ultimately to export one-third of her production.

The Marshall Plan administration has approved a three-year plan, which will cost 133,060,000 dollars, to modernise and expand iron and steel production in France. Production from two centres, Hayange and Ebange, amounting to 1,200,000 tons, will give an exportable surplus of at least 25,000 tons and enable high-grade sheet metal and tinplate to be exported. The programme, which is being carried out by "Sollac," will have two phases; the first includes the construction of a continuous hot rolling mill producing 700,000 to 850,000 tons annually, and a continuous cold rolling mill producing 350,000 tons of sheet and tinplate annually. The second stage includes the construction of eighty-four coking ovens to supply blast-furnaces at Hayange, additional steel capacity of 500,000 tons annually, a new blooming mill to supply the needs of the hot rolling mill and a continuous cold rolling mill. The programme is expected to be completed in 1952.

Notes and Memoranda

Rail and Road

CYCLE AND MOTOR-CYCLE EXPORTS.—Mr. Douglas Terry, President of the British Cycle and Motor Cycle Manufacturers' Union, has stated that the total value of cycles and cycle parts exported last year was £18,000,000, compared with £3,250,000 in 1938. Nearly 2,000,000 British bicycles were sold overseas. He also said that motor-cycle exports last year reached a value of £7,000,000, compared with £1,000,000 in 1938.

NIGERIAN RAILWAY ROLLING STOCK.—The Secretary of State for the Colonies, Mr. Rees-Williams, has announced in a parliamentary reply that sixty out of ninety-six main line locomotives ordered since the war for the Nigerian Railway have now been delivered. In addition, 432 wagons have also been delivered, and a further consignment of 637 wagons and wagon bodies is expected to be made this year. Most of this equipment, Mr. Rees-Williams added, had been supplied by the United Kingdom.

UNDERGROUND RAILWAY FOR CALCUTTA.—A report by *Indian Trade and Industry* says that the Government of India has approved a project to construct an underground railway for Calcutta at an approximate cost of £24,750,000. This underground railway, the first of its kind in India, it is stated, will be laid deeper than in most other cities, owing to soil conditions resulting from the heavy monsoon. The underground tunnels will be constructed entirely with cement concrete, instead of with cast iron pipes as in London. It is expected that the construction of the first 11 miles of the underground railway will be completed by 1952.

MOTOR VEHICLE PRODUCTION.—The Society of Motor Manufacturers and Traders says, in its monthly statistical review, that British motor vehicle production in May was at a record rate. The average weekly output for cars was 7900 units and for commercial vehicles 4400 units. The Society reports a steady increase since the beginning of the year in car exports to Canada, the total for the first five months of the year being 8500 units. Agricultural tractors exported in May numbered nearly 5000, which was 240 lower than the number exported in April. The value of the May tractor exports, however, was approximately £115,000 above the April figure.

CO-OPERATION IN THE MOTOR CAR INDUSTRY.—It will be recalled that in October last, Lord Nuffield and Mr. L. P. Lord announced that the Nuffield Organisation and the Austin Motor Company were to interchange information on production methods, costs, design, research, &c., with the object of effecting maximum standardisation and, by the pooling of all factory resources, consequent reduction of costs. The two companies now state that the preliminary investigations have been completed and although they will continue to consult together through the medium of the recently formed standardisation committee on matters affecting the motor industry as a whole, the interchange of confidential information has ceased. No further steps will be taken with regard to the pooling of production resources and no merger of any kind is contemplated.

Miscellanea

OBITUARY.—We learn with regret of the death of Mr. Edward Alexander, A.M.I.C.E., sales director of Arthur Dixon and Co., Ltd. The funeral took place at Chard, Somerset, on July 12th. All Mr. Alexander's duties have been taken over by Mr. H. S. Campion, managing director of the company.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—Revised rules for examinations and regulations governing admission to membership by examination have now been issued by the Institution of Heating and Ventilating Engineers, 75, Eaton Place, London, S.W.1. These new rules will take effect as from January 1, 1951.

INSTITUTION OF ELECTRICAL ENGINEERS' PREMIUMS.—The Council of the Institution of Electrical Engineers has announced the award of a number of premiums for papers read or accepted for publication during the session 1948–49. The list of awards includes the Kelvin Premium to C. W. Earp, B.A., and R. M. Godfrey, B.Sc. (Eng.); the John Hopkinson Premium to G. F. Shotter; and the Silvanus Thompson Premium to Professor F. C. Williams, O.B.E., D.Sc., D.Phil., and T. Kilburn, M.A. Students' premiums were awarded as follows:—Value £10, to J. W. R. Griffiths, P. H. Hammond, B.Sc., H. A. Prime, B.Sc., and J. R. Walters; value £5, to B. D. Jenkins, B.Sc., A. K. McAuslan, I. J. Shelley, and D. J. Whythe.

COALS OF THE COMMONWEALTH.—An exhibition, believed to be more complete and representative than any previously held, of the coals of the British Commonwealth and of new methods for examining and processing coals, has been arranged by Powell Duffryn Technical Services, Ltd., at its research laboratories at 140, Battersea Park Road, S.W.11, in connection with the Fourth Empire Mining and Metallurgical Congress.

INDUSTRIAL FINISHES EXHIBITION.—A new space plan has been prepared for the Industrial Finishes Exhibition, which is to be held at Earls Court, London, from August 23 to September 5, 1950. The Council of Industrial Design has reaffirmed its decision to give every support in its power to this exhibition. Arrangements are now being made also for the scientific congress on industrial processes, which will be held simultaneously with the exhibition.

ALUMINIUM DOORS.—On Monday, July 18th, a presentation of some new aluminium entrance doors was made at the Building Centre, 9, Conduit Street, W.1. The doors have been presented to the Building Centre by the Aluminium Development Association and will form a permanent exhibit of aluminium in actual use in the building. Coinciding with the presentation of the new doors, the Association introduced to the Building Centre a new aluminium exhibit, by members of companies of the Aluminium Development Association, consisting of a display of aluminium components used in structural work and in architectural and domestic installations. Subsequent displays will illustrate the latest developments of the use of aluminium alloys in building.

"CO_2 AND DRAUGHT."—A film, entitled "CO_2 and Draught," has been produced by Central Office of Information Films for the Ministry of Fuel and Power, with the intention of instructing boilermen and firemen in some aspects of the firing and maintenance of boilers. Animated diagrams and simple explanations are used throughout, and the chemistry of carbonisation and the physics of heat are indicated. The film also shows some practical points of maintenance that should be followed. as well as illustrating correct methods of laying and firing. The film runs for twenty minutes and will be distributed to special audiences through the C.O.I. mobile units. Sixteen-millimetre copies will be available on free loan from the Central Film Library, Imperial Institute, London, S.W.7, from the beginning of August.

A TRAVELLING X-RAY THEATRE.—The Ministry of Works has designed and produced a special vehicle with which to equip mass radiography units operated by Regional Hospital Boards as part of the National Health Service. Up till now, most of these units, although readily transportable from one point of installation to another, have not been as essentially mobile in operation as has been intended since the scheme was begun during the war. The interior of the new vehicle is divided into two compartments separated by a fixed partition and light-tight door, one being the examination compartment, where the X-ray apparatus is installed, and the other a "waiting room" which can be turned into a complete darkroom for processing the films. The examination room is fitted with Watson apparatus consisting of a high-tension generator, an X-ray tube column unit, a screening and camera unit, a control unit, and protective screens and curtains. The electrical energy is normally taken from the British Electricity Authority's mains.

SILICONE RUBBER INSULATED CABLES AND WIRES.—We learn that the maximum working temperature of silicone rubber insulated cables and wires manufactured by British Insulated Callender's Cables, Ltd., will be raised to 150 deg. Cent. Silicone rubber insulation is applied by this company to the manufacture of cables and flexibles having conductor sizes conforming to B.S. 7, and of radio connecting wires. Insulating sleevings in a wide range of sizes and colours can be supplied. Cables with silicone rubber insulation are suitable for use as thermocouple leads, as instrument leads and connections in boiler-houses, for wiring drying kilns, furnaces, ovens, ships' engine-rooms and gas turbine aero-engines. The principal reasons why silicone compounds possess remarkable temperature stability are the presence of the silicon atoms and the strength of the silicon-oxygen bond. For high-temperature work silicone rubber combines great flexibility and resistance to moisture and can withstand continuously, without deteriorating, a wide range of working temperatures, from below 0 deg. Cent. to 150 deg. Cent.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

British Standards Institution

Wed., July 27th.—24, Victoria Street, Westminster, S.W.1, Annual General Meeting, 3 p.m.

Empire Mining and Metallurgical Congress

To-day, July 22nd, and Sat., July 23rd.—Grosvenor House, Park Lane, W.1.

British Power Press Manufacturers' Association

Tues., July 26th.—Standbrook House, Old Bond Street, London, W.1, General Meeting, 2.30 p.m.

Engineering and Marine Exhibition

Thurs., Aug. 25th, to Sat., Sept. 10th.—Olympia, London.

Personal and Business

CLIMAX MOLYBDENUM COMPANY OF EUROPE, Ltd., announces the resignation from its board of Mr. A. D. Storke.

MR. LANCELOT S. MILLS has resigned his directorships of De La Rue Extrusions and De La Rue Floors and Furnishings, Ltd.

THE HOPKINSON ELECTRIC COMPANY, Ltd., has opened a new office at 97-99, Waterloo Street, Glasgow, C.2, (telephone Central 2491), under the management of Mr. William Murdoch.

THE BRITISH ELECTRICAL AND ALLIED MANUFACTURERS' ASSOCIATION WELDING SECTIONS have nominated Mr. R. W. Ayers as their representative to the B.E.A.M.A. Council for 1949–1950.

COOPER AND SONS (SHEFFIELD), Ltd., announces that its Fuluse Works, Hermitage Street, Sheffield, will be closed down for annual holidays from July 23rd to August 2nd, both dates inclusive.

DOW-MAC (CONSTRUCTION), Ltd., announces that Mr. R. F. Turner is no longer a director of the company. The board now consists of Mr. H. L. Dowsett, Colonel R. B. Emerson, Mr. T. E. Grant and Mr. E. McCann.

THE LONDON MIDLAND REGION OF BRITISH RAILWAYS announces the following appointments:—Mr. G. D. S. Alley, permanent way assistant, civil engineer's department, Euston; Mr. B. P. Blackburn, district motive power superintendent, Carlisle (Upperby); Mr. C. S. Longsdale, district motive power superintendent, Bescot; Mr. J. H. Knight, divisional carriage and wagon outdoor assistant, C.M.E.'s department, St. Pancras.

RICHARD CRITTALL AND CO., Ltd., has been reorganised and now consists of the parent company (Richard Crittall and Co., Ltd., 151, Great Portland Street, W.1), Richard Crittall Marine, Ltd., Grierson, Ltd., and Air Ducts, Ltd.; a half interest is retained in the Magnetic Valve Company, Ltd. The chairman of the new board is Mr. Geoffrey C. R. Eley, and the directors are Sir George E. Cuffe (managing director), Mr. J. P. Hamill, Mr. W. R. Cox and Mr. G. F. Wattears. Branch offices are at Prudential Buildings, St. Philip's Place, Birmingham, 3, under the managership of Mr. J. C. Longley; at Martin's Bank, Water Street, Liverpool, under the directorship of Mr. J. P. Hamill, and 93, Hope Street, Glasgow, C.3, under Mr. B. Jewell. Richard Crittall Marine, Ltd., has headquarters at 661, Royal Liver Building, Liverpool, 3; Grierson, Ltd., at St. George's House, 195, Waterloo Road, S.E.1, and Air Ducts, Ltd., at 195, Stamford Brook Arches, Hammersmith, W.6.

Codes of Practice

The Codes of Practice Committee for Civil Engineering, Public Works and Building and Constructional Work is under the ægis of the Ministry of Works. Codes are issued on behalf of the Committee by the British Standards Institution, 24–28, Victoria Street, London, S.W.1.

FARM AND HORTICULTURAL ELECTRICAL INSTALLATIONS

The Council for Codes of Practice for Buildings has now issued as a draft for comment Code 325, "Farm and Horticultural Electrical Installations." It has been prepared on the Council's behalf by a Committee convened by the Institution of Electrical Engineers and incorporates in one document the following head code and sub-codes:—Code 325, Farm and Horticultural Electrical Installations; Sub-Codes 3, 25.101, Farm Consumers' Distribution; 325.102, Farm Wiring; 325.103, Farm Lighting; 325.104, Farm Heating Installations; 325.105, Farm Motive Power; 325.106, Horticultural Installations.

The code deals with the provision of electrical installations in and around farm buildings, nurseries, market gardens and private gardens, and is applicable both to new installations and to the modernisation and extension of existing installations. It is not intended to take the place of a detailed specification and the assumption is made that the work is carried out under qualified supervision. The code covers a wide scope and is thoroughgoing in its treatment, incorporating a valuable body of detailed information on modern practice.

The head code deals with the more general aspects of the subject. It points out the need for liaison, at the planning stage, between all parties concerned, in order to determine the location of the main controls and the lay-out of the consumer's distribution in the light of the immediate applications proposed and possible future extensions. It surveys the operating conditions to which installations may be subjected, and also deals with earthing, battery charging and the provision of electric fences.

Each sub-code includes a list of relevant British Standards, while cross-references to the head code and to other sub-codes are inserted wherever appropriate.

The code includes seventeen diagrams illustrating overhead line arrangements, typical lighting lay-outs for cow-houses, and typical lay-outs for dairy sterilising and washing equipment. Soil warming circuit diagrams are also included.

The code carries the usual warning that during the present abnormal conditions it may not be practicable to take full advantage of all the recommendations in it. It is subject, before final publication, to revision in the light of comments received; comments, which are invited and welcome, should be submitted by August 10, 1949.

Copies of the draft code, proof reference CP(B) 869, may be obtained from the British Standards Institution, Sales and Distribution Department, 24, Gillingham Street, London, S.W.1, price 9s. post free.

Technical Reports

Ageing of Composite Dielectrics: Changes in Electrical Properties (Report from the Research Association of British Rubber Manufacturers). The British Electrical and Allied Industries Research Association (Ref. B/T46). Price 6s., postage 3d.—The study of the effects of ageing on the properties of a representative selection of dielectrics, already partly reported in B/T29 and B/T32, has been completed by experiments on electrical properties (power factor, permittivity, breakdown strength and surface resistivity) and plastic yield. The ageing conditions used were normal (25 deg. Cent., 75 per cent R.H.), tropical, and hot (in air at grade temperature).

The effects of normal ageing up to seventy-two weeks on electrical properties are small, but (with dielectric loss and breakdown strength at least) usually in an adverse direction, indicating an ultimate deterioration in electrical properties, such as might be expected with organic materials owing to oxidation. The high humidity of tropical ageing caused dielectric loss to increase and breakdown strength to decrease by amounts that varied greatly from material to material, but surface resistivity did not in general suffer seriously. On the other hand, the drying effect of grade-temperature ageing often improved dielectric loss and surface resistivity, though the effects on breakdown strength were variable. Resistance to plastic deformation at elevated temperatures generally improved during grade-temperature ageing, but tended to deteriorate during normal ageing; tropical ageing produced intermediate effects.

The materials arrange themselves in different orders of stability according to the property considered, but, broadly speaking, the materials of the ebonite type (especially unloaded ebonite) were the most stable, as found previously with respect to dimensions and impact strength; the phenol-formaldehyde, urea-formaldehyde and casein-base materials were generally the least stable, again agreeing with the dimension and impact strength results in respect of the casein-base material, but not for the synthetic resin types, which showed better stability in these properties than in electrical properties.

The Characteristics of Short Discharges. By W. Nethercot, M.A., B.Sc., F.Inst.P., and C. E. R. Bruce, M.A., B.Sc., M.I.E.E., F.Inst.P. The British Electrical and Allied Industries Research Association (Ref. L/T205). Price 12s., postage 3d.—A recent suggestion that complete breakdown to arc conditions occurs in the leader stroke of the lightning and long spark discharges has given added interest to any work likely to have a bearing on this question. One such investigation is that undertaken by the E.R.A. to determine the minimum energy in capacitative discharges across a small gap required to cause ignition of flammable gas mixtures. This involved the direct measurement of the gap voltage and current during the discharge by means of a high-speed oscillograph.

The present report shows how the gap voltage varies with the current when an 0·02 microfarad capacitor, charged to approximately 5kV, is impressed across a gap of width 0·92mm between 0·25in steel balls in series with a resistance varying from 50 ohms to 50,000 ohms. This gave peak currents in the discharge lying between 100A and 0·1A.

In addition tests were made with an inductance in series, in order to obtain an oscillatory discharge and so to allow the phenomena occurring around current zero to be investigated.

Carbonisation of Switch Oil: Preliminary Report. By A. Kobler, B.Sc. The British Electrical and Allied Industries Research Association (Ref. G/T212). Price 6s., postage 3d.—This report records the results of a preliminary examination of the circumstances in which carbon might be deposited on insulator surfaces in switch oil in quantity and condition conducive to breakdown over such surfaces. The work aims at development of methods of obviating or minimising the possibility of occurrence of such conditions.

The aspects considered are possible differences in the amount and type of carbonisation, caused by differences in the electrical conditions under which a switch may be required to operate; visible differences in the carbonisation produced, and the presence of other products of arcing which might influence liability to failure.

The Origin of Solar Noise. By C. E. R. Bruce, M.A., B.Sc., M.I.E.E. The British Electrical and Allied Industries Research Association (Ref. L/T204). Price 6s., postage 3d.—During the war it was established that the sun radiates a relatively great amount of energy in the short-wave radio bands, which can on occasion interfere with television broadcasts and radiolocation. The present report suggests that the electrical discharge theory of astrophysical phenomena outlined in an earlier publication offers an explanation for both the steady background "noise" received from the sun in the short-wave radio bands, and for the sudden outbursts which occur during disturbed solar conditions.

Some terrestrial magnetic storms may be the direct effect of the "atmospherics" radiated from solar atmospheric electrical discharges, in which the currents which must flow are estimated to be of the order of 10^{14}A. The theory would account for the change in polarity observed in many magnetic storms, and for the high temperatures of the sources of solar noises.

Zeeman Effect in Astrophysical Spectra. By C. E. R. Bruce, M.A., B.Sc., M.I.E.E. The British Electrical and Allied Industries Research Association (Ref. L/T208). Price 3s., postage 3d.—This report describes a development of the ideas put forward in Ref. L/T204. A confirmation of the figure given for the current in a solar discharge is obtained by a calculation of the Zeeman effect expected to be produced by the magnetic field due to the discharge. The calculated broadening of the spectral lines is found to be in good agreement with actual measurements.

Launches and Trial Trips

LOCHWOOD, motor cargo ship; built by the Burntisland Shipbuilding Company, Ltd., for Wood Lines, Ltd.; length 276ft, breadth 41ft 9in, depth 26ft 9in, 2350 tons deadweight; eight-cylinder, 1200 b.h.p. marine diesel engine, 340mm diameter by 570mm stroke, supplied by British Polar Engines, Ltd. Launch, July 13th.

CAZADOR, motor tanker; built by Harland and Wolff, Ltd., for Estrella Maritima S.A. de Navigacion y Commercio; length 425ft, breadth 54ft 3in, depth 31ft, 9300 tons deadweight; Harland-B. and W. four-cycle, crosshead type diesel engine, with six cylinders, 650mm bore and 1400mm stroke. Completed June 16th.

CITY OF PHILADELPHIA, cargo steamer; built by Furness Shipbuilding Company, Ltd., for Ellerman Lines, Ltd.; length 485ft 3in, breadth 61ft 6in, depth 41ft 9in, 10,880 tons deadweight; Parsons impulse reaction turbines, 7200 s.h.p.; two Babcock and Wilcox water-tube boilers working at pressure of 275 lb per sq. in. Launch, July 12th.

THORISLE, motor cargo liner; built by the Burntisland Shipbuilding Company, Ltd., for A/S Thor Dahl, Norway; length 390ft, breadth 53ft 6in, depth 34ft 6in, 6265 tons deadweight; four-cylinder, 4400 b.h.p., single-screw, Hawthorn-Doxford opposed-piston diesel engine, 670mm diameter by 2320mm stroke, supplied by R. and W. Hawthorn, Leslie and Co., Ltd. Trial trip, June 21st.

A Seven-Day Journal

The Iron and Steel Bill

On Monday, July 25th, and Tuesday, the following day, the House of Lords' amendments to the Iron and Steel Bill were considered in the House of Commons, in a sitting which lasted nearly twenty-two hours. At the beginning, Mr. Strauss, the Minister of Supply, announced that of the total of about sixty amendments moved in the House of Lords, the Government proposed to accept twenty-eight, most of which were concerned with drafting points. The other amendments, Mr. Strauss said, numbered thirty-two and could be reduced to a group of about twelve, divided into two categories. The Government proposed to move that they be not agreed to. The first category was concerned with fundamental principles on which the Government and the Opposition were divided. The second category was concerned, he said, with less important proposals which raised no question of fundamental principle, but which, in the opinion of the Government, would make the task of the Corporation, in running the iron and steel industry efficiently, more difficult or even impossible. There were also other proposals which, in the view of the Government, would harmfully or unreasonably confine the activities of the Iron and Steel Corporation and public-owned companies to the detriment of the iron and steel industry and industry generally. In the course of the long sitting Mr. Strauss made it known that the Government firmly intends that the Bill should become law as early as possible. Should the amendments defeated in the Commons, including that for postponing the vesting date from May 1, 1950, to July 1, 1951, be insisted upon in the Lords, with the consequence that the Bill was not passed in this session, it was the firm intention of the Government to pass it into law at the earliest possible practicable date. In particular, he said, it should be known that when the Bill was again presented it would contain the provisions concerning the disclaimer of agreements and leases, the control of dividends, the power to acquire securities of certain additional companies, the prohibition of the transfer of iron and steel works and the recovery of assets and other transactions resulting in the dissipation of assets. The Government would definitely adhere to those provisions, and they would be retrospective to the same dates as those provided for in the Bill. The remaining amendments were considered late on Tuesday evening and the House rose shortly before one o'clock on Wednesday morning.

Lloyd's Register Shipbuilding Returns

The quarterly statistics published by Lloyd's Register of Shipping, show that at the end of June last in Great Britain and Northern Ireland there was a decrease of 32,902 tons in the work in hand as compared with the figures for the previous quarter. The present total of 2,043,008 tons gross is 200,695 tons less than the tonnage which was being built at the end of June, 1946, which amounted to 2,243,703 tons and was the highest recorded since December, 1921. At the end of June work was suspended on 1180 tons. About 37 per cent or 756,854 tons of the ships being built in this country is intended for registration abroad or for sale. The returns indicate that of the ships intended for registration abroad twenty of 107,740 tons were begun in the June quarter. The tonnage of steam and motor merchant vessels under construction abroad at the end of June was 2,403,062 tons gross, a figure which is 123,467 tons in excess of that recorded at the end of March last, when, it was noted, no figures were included for Germany, Japan and Russia. These reservations still apply, and it is known that the figures now shown for Japan are incomplete especially with regard to ships of less than 1000 tons. The tonnage of steamers and motorships under construction in the world, apart from the countries excluded, as above mentioned, amounts to 4,446,070 tons gross, of which 46 per cent is being built in Great Britain and Northern Ireland, and 54 per cent abroad. During the quarter under review, in Great Britain and Northern Ireland, 287,850 tons of steamers and motorships were begun, 357,745 tons were launched, and 339,012 tons completed. Of the ships under construction at the end of June in Great Britain and Northern Ireland 828,796 tons consisted of steamers and 1,214,212 of motorships. Steam and motor tankers of 1000 tons and upwards under construction in the world amount to 154 ships of 1,667,000 tons, including 45 steamers of 652,121 tons and 109 motorships of 1,014,879 tons. This represents an increase of 140,177 tons in tankers since the end of March. In the tonnage built to Lloyd's Register and British Corporation Class, 3,015,149 tons, or 67·8 per cent, are being built under the inspection of Lloyd's Register. Of the total, 1,934,698 tons, representing 94·7 per cent of the tonnage being built there are under construction in Great Britain and Northern Ireland, while of the tonnage being built abroad 1,080,451 tons, or 45 per cent, are being constructed under the inspection of Lloyd's Register.

The Mineral Development Committee Report

The report of the Mineral Development Committee, appointed in August, 1946, by the Minister of Fuel and Power, has now been published as a Blue Book Cd. 7732, price 2s. net, by the Stationery Office. The terms of reference of the Committee were: "To inquire into the resources of minerals in the United Kingdom, excepting coal, oil, bedded ironstone, and substances of widespread occurrence; to consider possibilities and means for their co-ordinated orderly and economic development in the national interest, and to make recommendations in regard thereto." The Committee, which met under the chairmanship of Lord Westwood, heard evidence from individuals, mining companies, institutions and other bodies. The report deals with production and the mineral resources of the United Kingdom, and the mineral resources of England and Wales, Scotland and Northern Ireland are individually dealt with fully. Past and present national policy is discussed, and also mining taxation and mineral rights and planning, after which the principles of future policy are dealt with. The need for further technical information concerning mineral resources is stressed and the future of mineral development outlined. It is recommended by the Committee that the Minister of Fuel and Power should establish a new permanent organisation called the Mineral Development Commission, which would be largely technical in character, and would be charged with specific functions and duties and with relationships to other Departments with regard to mineral development. The "fee simple" in the minerals dealt with in the report should, it is recommended, be acquired by the State, and together with the "development value" at present vested in the Central Land Board, should be transferred to the new Commission. Production responsibility for the minerals, at present with other Government Departments, should, it is suggested, be transferred to the Minister of Fuel and Power. Further recommendations relating to mining taxation, and wolfram and tin ore resources, at present with the Ministry of Supply, are made, and it is specially emphasised that the new Yorkshire potash beds near Whitby should be developed by a joint company representing the State, and firms interested in potash production, until the Mineral Development Commission is formed, or they should be nationalised separately, as were the petroleum mineral rights under the Petroleum (Production) Act of 1934. Mining records at present in private hands should be preserved, and more detailed official statistics should be published regarding the mineral industries. One member, Mr. Peter Thorneycroft, dissented from the two main conclusions, to nationalise minerals, and to establish a Mineral Development Commission. In the House of Commons on Monday, July 25th, Mr. Gaitskell, the Minister of Fuel and Power, said that the Government had decided to accept the main recommendation that the minerals included in the terms of reference to the Committee, should be brought into public ownership, and the necessary legislation would be introduced.

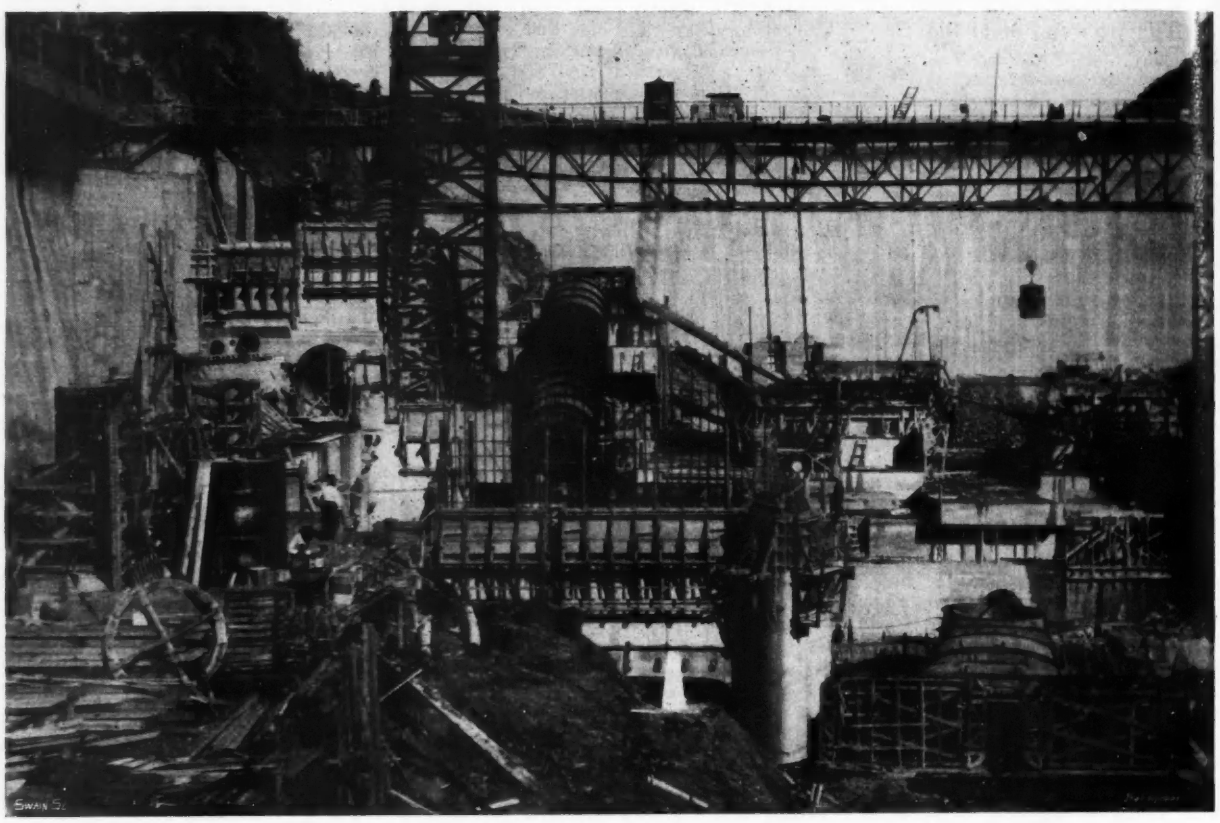
Training and Leadership in Industry

A convention to obtain the opinions of young engineers from all parts of the country on training and leadership in industry has been organised by the Birmingham Graduate Section of the Institution of Production Engineers. This convention, which will be held at Birmingham University on Saturday, September 3, 1949, will provide a platform from which engineers up to the age of thirty years will be able to make known their views to those responsible for the future of youth, both in industry and in the field of technical education. All graduate and student members of the Institution will be invited to attend the convention. After an opening address by Professor T. U. Matthew, two addresses will be made. The first address, by Mr. T. B. Worth, the education officer of the Institution, will deal with "Qualification and Further Education," and the second, by Mr. K. R. Evans, the manager of the education department of the Metropolitan Vickers Electrical Co., Ltd., with "Industry's Part in Balanced Training." These two subjects will then be discussed by the meeting for an hour and a quarter. Prior to the opening of the afternoon session a tour will be made of the electron physics, electrical engineering and production engineering departments of the Birmingham University. The president-elect of the Institution, Major General K. C. Appleyard, will then present an address: "Youth and Leadership in Industry," for discussion. The convention will close with a summing up of the day's discussions and papers by Professor Matthew.

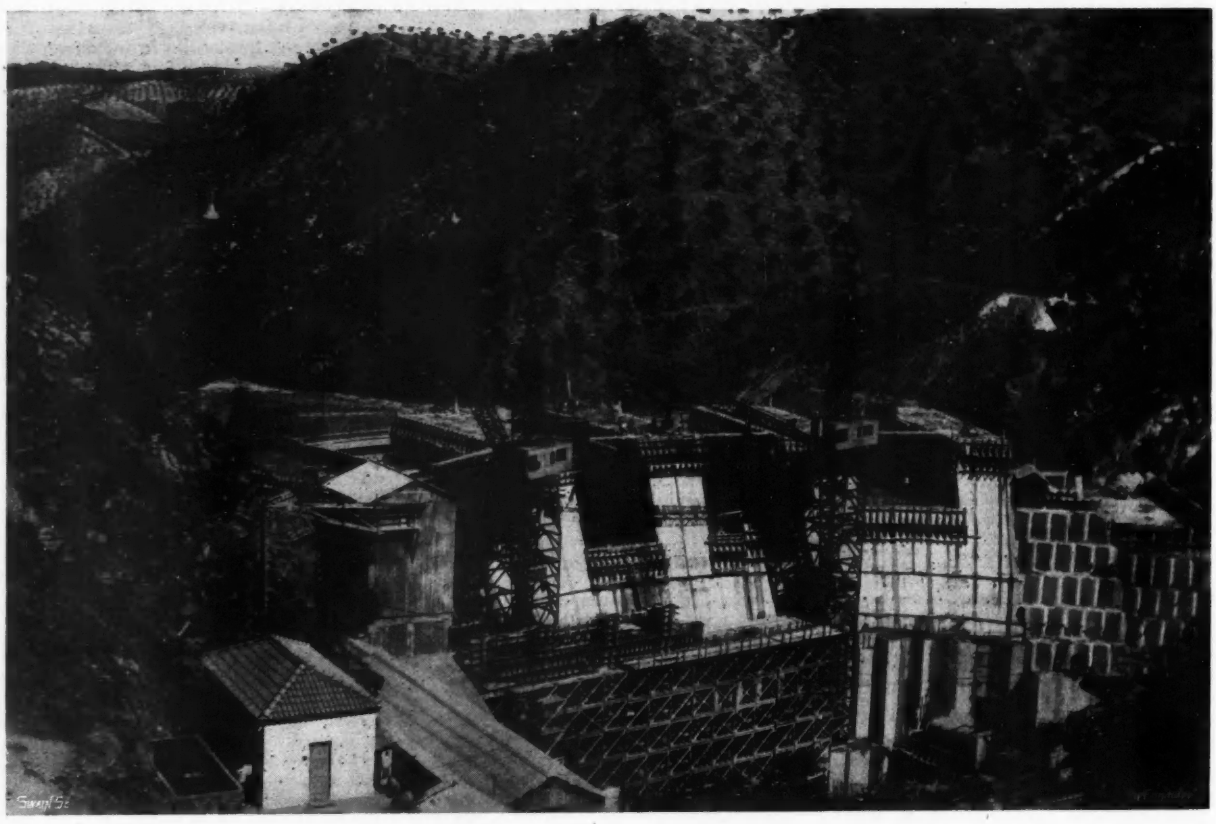
Road Haulage Business Compensation

Replying in the House of Commons, on Monday, July 25th, to a question regarding the payment of compensation for the compulsory acquisition of road haulage businesses, the Minister of Transport stated that the British Transport Commission could not make payments on account of compensation until the properties affected by the notice of acquisition had been identified and agreed and a provisional ascertainment made. The position at June 30, 1949, was that 469 road-haulage undertakings had been transferred, of which 123 were taken over only in June and 131 in May. Out of the total of 469 there were thirty-five cases in which the extent of the transfer had not been agreed, and 148 cases in which the Commission was awaiting accounts and other information from the transferors. Provisional ascertainments in 130 cases had been calculated, or were in hand, and payment on account would be made as soon as the legal title was verified and other essential formalities were completed. Other cases were, he said, awaiting valuers' reports and other information. He was satisfied that the intention of the Commission was that all acquired undertakings should receive a payment on account at the earliest moment and there was no need for him to issue directions. Machinery had been set up to expedite settlements and he was informed that undertakings which might otherwise suffer hardship were being offered an immediate payment in respect of their cash option. Speedy progress in respect of both acquired undertakings and of those yet to be acquired would depend largely, he felt, on the co-operation of the transferors.

CONSTRUCTION OF CASTELO-DO-BODE DAM, PORTUGAL



PROGRESS IN OCTOBER, 1948

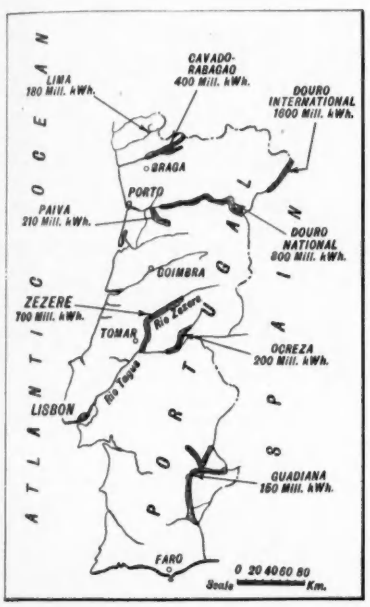


GENERAL VIEW IN MARCH, 1949

Construction of the Castelo-do-Bode Dam, Portugal

No. I

IN 1945 the Portuguese Government created two companies, the Hidro-Electrica do Zezere and the Hidro-Electrica do Cavado, to construct and operate hydro-electric plants on the rivers Zezere and Cavado (Rabagao). The reorganisation of industry in Portugal required, in the first place, the provision of electric power for basic industries, and the formation of these companies implemented the policy of the Portuguese Government contained in a law passed in 1944. This law was designed to encourage the development of water power to the greatest possible extent, and stipulated that the Government would participate in the capital of the power production companies.



PROJECTED HYDRO-ELECTRIC SCHEMES

A policy of controlled economy for the electrification of the country was thus laid down, which, while avoiding complete nationalisation, resulted in Government supervision by means of their representatives on the Boards and of special superintendence from the official departments. The companies, however, maintain their private standing.

The concession granted to the Zezere Company consists of the hydro-electric development of the Zezere River for a length of 140km (87 miles) above its junction with the Tagus, over which distance there is a fall of 275m (904ft). This length of the Zezere River is indicated on the map of Portugal above, which also shows various other projected hydro-electric developments on Portuguese rivers. In order to take the greatest advantage of the fall and to provide the large reservoirs required to control the irregular flow of the river, four sections were established. The principal characteristics of these sections are given in the accompanying table.

The order of construction was determined by the necessity of forming a large storage reservoir as quickly as possible, and it was accordingly decided to commence with the construction of the Castelo-do-Bode dam.

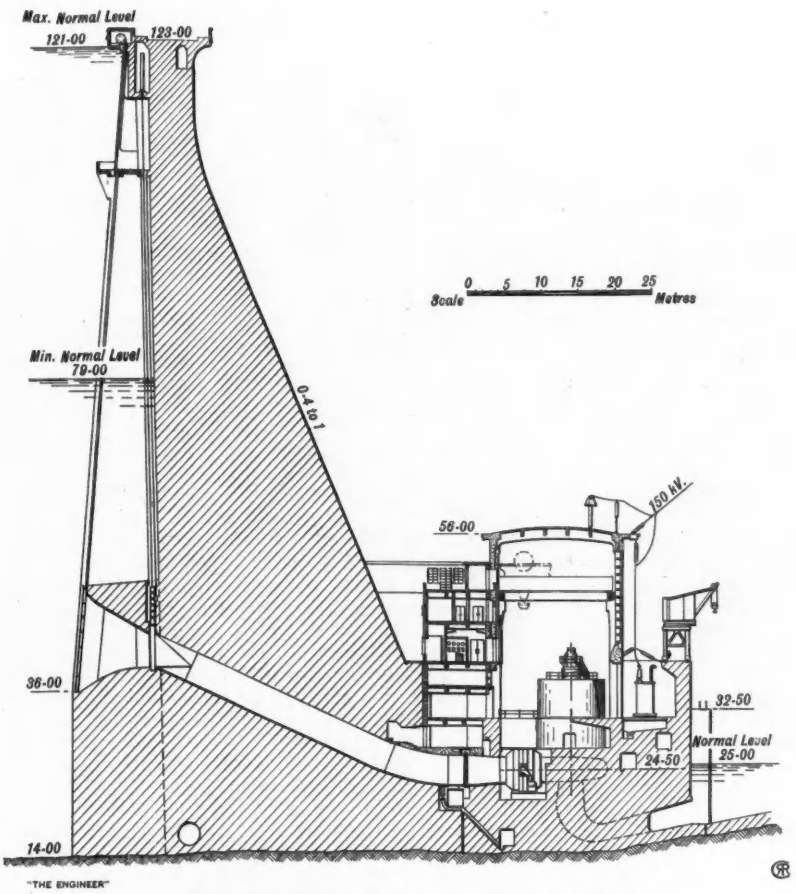
General Description of Castelo-do-Bode Scheme

The Dam.—The dam is of the arch type, with a maximum height of 377ft and a vertical upstream face of 492ft radius. The downstream face has a variable inclination of 0·40 at the centre, increasing to the abutments. The arch was designed to suit the local topographic conditions, but an artificial abutment was necessary on the right-hand bank. The total volume of concrete in the completed structure will be 400,000 cubic metres (523,000 cubic yards) and the completed excavation for the foundations will total about 100,000 cubic metres (131,000 cubic yards). The catchment area supplying the dam is 3950 square kilometres (1500 square miles), which, with an average rainfall of 1200mm (47in), gives an average river flow of 75 cubic metres a second (2650 cusecs). A cross section of the dam and power-house is given below.

The Spillway.—The spillway was designed for a discharge of 4100 cubic metres per second (145,000 cusecs). It is incorporated in the dam on the left bank, independently of the power station. Exhaustive and elaborate experiments were carried out with models before the various problems concerned with the inlet and discharge to the river channel were overcome. It was found to be impracticable to maintain the normal section, and a system of forced discharge through two large openings was adopted, the flow being regulated by two sector pivot gates at the outlets of the discharge openings. The ultimate discharge to the river channel presented difficulties owing to the restricted space between the power-house and the river bank, and owing to danger of erosion. A system of vertical discharge, joining the channel in the direction of, and at the level of, the natural flow,

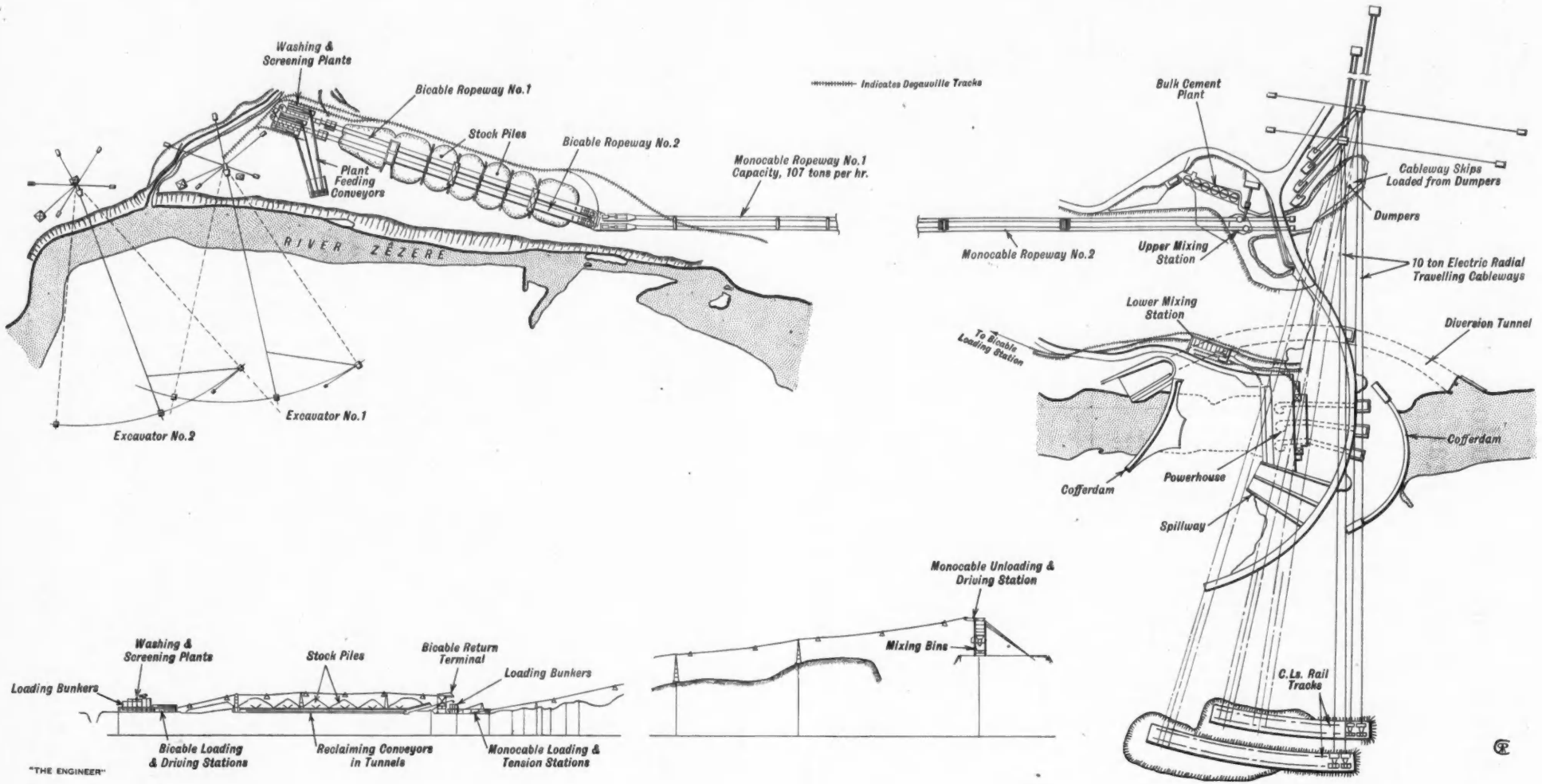
River Zezere Power Scheme

Sites of dams and power stations (from upstream end)	Height of dams		Total capacity of reservoirs		Maximum gross head		Horse-power	Firm output per year, kWh
	Metres	Feet	Cu m	Acre-feet	Metres	Feet		
Cabril	125	410	600	486,450	115–65	377–213	146,000	190 mill.
Bouca	65	213	49	39,700	54	177	90,000	110 mill.
Castelo-do-Bode... ...	115	377	1070	867,500	96–65	312–213	186,000	380 mill.
Constancia	12	39	5	4,100	7	23	12,000	20 mill.



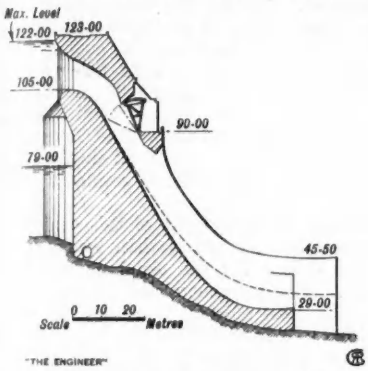
CROSS-SECTION OF DAM AND POWER-HOUSE

ARRANGEMENT OF PLANT FOR BUILDING THE CASTELO-DO-BODE DAM



was finally adopted. A cross-section through the spillway is given below.

Power Station.—Three water turbo-alternator sets will be installed in the power station. They are to be of the vertical type, developing 62,000 h.p. at a normal head of 80m (263ft) and operating at 214 r.p.m. On the spiral casing inlet a valve of the spherical type is incorporated, having a diameter of 3·30m (10ft 10in). The three main penstocks, each 4m (13ft 2in) in diameter, are embedded in the concrete of the dam, thus enabling them to have a metal thickness smaller than would be necessary if they were designed for open-air conditions. They are each stiffened by means of continuous angle



CROSS-SECTION OF SPILLWAY

reinforcements attached round their periphery, thus strengthening them against inward pressure caused by any infiltration through the dam. The penstocks are closed on the upstream face by caterpillar gates, designed to close rapidly in case of emergency.

The alternators, of 57,400kVA capacity at maximum continuous rating, operate at a generating voltage of 15,500V and have closed ventilation. The main step-up transformers have a ratio of 15·5kV to 165kV, with delta-star connection. They are installed in a situation downstream from the machine room, thus allowing the electrical connection to the sub-station to be carried by the downstream wall of the power station building. These overhead high-voltage transmission lines connect the sets to the 150-kV bus-bars at the sub-station further up on the right-hand bank.

Two discharge regulators of the cylindrical balanced type are installed at the downstream wall of the power station at the end of the two scour culverts, one in each bank. They are each closed on the upstream face of the dam by means of a caterpillar gate, which is remotely controlled.

Constructional Programme

The programme of construction of the works was arranged to ensure operation of the power station by 1950–51. The Zezere Company decided that they should purchase the required constructional plant themselves and supply it to the contractors on agreed terms. This procedure ensured that the most suitable plant was available for the fulfilment of the programme and would provide the plant subsequently required for the construction of the other dams included in the development scheme. Furthermore, an agreement was signed between the Zezere Company and the English Electric Export and Trading Company, Ltd., and the Metropolitan-Vickers Electrical Export Company for the supply of the whole of the generating plant and sub-station equipment.

After careful consideration of quotations received from several countries, the company placed orders for almost the entire constructional plant required with a group of British suppliers formed by Pauling and Co., Ltd., of London, at the invitation of E. Pinto Basto and Cia., Ltda., and Monteiro Gomes, Ltda., two long-established firms in Lisbon. Pauling and Co., Ltd., advised on the type and general arrangement of the constructional plant and co-ordinated the work of the individual members of the group. Pinto Basto, Ltda., and Monteiro Gomes, Ltda., carried out the negotiations with the Zezere Company, and Nobrega de Lima, Ltda., Norton and Co., Ltd., and the Engineering Company of Portugal gave valuable assistance as agents for a number of the suppliers.

The main contractors for the construction of the hydro-electric works are Monez da Maia and Vaz Guedes, Ltda., who are making rapid progress, as will be observed from the illustrations on page 112.

The diversion of the river was carried out in a very short time and was complete by September, 1947. It involved the construction of a concrete-lined tunnel, 740ft long, with a horseshoe section, 39ft wide by 33ft high, giving a sectional area of 1023 square feet and a capacity of 72,400 cusecs. This work involved 56,000 cubic yards of excavation and the placing of 13,000 cubic yards of concrete. The cofferdams are of great size, the upstream one being an arch dam in concrete with a height of 115ft at the deepest section. The concrete wall in the background of the upper view on page 112 shows this upstream cofferdam.

Lay-out of Constructional Plant

The remaining sections of this article are devoted to a description of the lay-out and operation of the constructional plant at Castelo-do-Bode dam, supplied by the British group of manufacturers. The lay-out of the dam and plant is shown opposite. The sand and gravel used for concrete aggregate is obtained from the river bed by six electrically driven, 1½ cubic yard, cableway, dragline excavators. These excavators are situated about 1½ miles downstream of the dam and span the river at advantageous points where there are deposits of sand and gravel ranging to 45ft in depth.

The excavators deliver the aggregate into hoppers, from where it is transported by trucks to three washing and screening plants. Two bi-cable ropeways transport the graded aggregates from the washing and screening plants to stock piles; a system of conveyor belts runs underneath these stock piles and different grades of aggregate can thus be fed to two monocable ropeways as they are required for use. The monocable ropeways transport the aggregates over a distance of about a mile and a quarter to the storage hoppers of the main mixing station. A bulk cement handling plant is situated close to this mixing station. Concrete is delivered from the mixing plant into dumpers, which transport it to the skips of one of four ropeways which span the entire length of the dam.

A subsidiary mixing station is installed just downstream of the dam. This station was intended for use before the upper mixing station and ropeways were in operation. Aggregates are transported to this station by road from the storage heaps and two 7-ton monotower cranes are used to handle the concrete.

(To be continued)

The Engineer in Hong Kong

By Professor C. A. MIDDLETON SMITH, M.Sc., LL.D., M.I. Mech. E.

"WE should realise not only that we here in the United Kingdom have in the past held a position of tremendous importance in the Far East (and it is still of vital importance to us, and to the Dominions of Australia and New Zealand, and at least one-half of Canada), but that the situation in the Far East is of more immediate and direct importance to us than even the situation in Europe. It is a pity we are not told more about it." Those words were spoken this year by Mr. Comyns Carr, K.C., during an address to members of the Royal Empire Society. He concluded his address as follows:—"From the point of view of our British prestige in the Far East there is one outstanding thing and that is that in all the welter of misgovernment, corruption and tragedy in China, and some other parts of the Far East, British prestige, British administration, have made of one of our Colonies in that part of the world, Hong Kong, an astonishing oasis of prosperity, prosperity which we can hardly realise at home in this country." General Smuts has recently expressed similar views.

During recent weeks the newspapers in Britain have devoted space to the views of experts concerning the defence of Hong Kong. Tributes have been paid by various visitors to the Far East to British administration and justice in Hong Kong, but the only eminent person, in my experience, who has praised the work of engineers in Hong Kong was Dr. Sun Yat Sen, and that was about twenty-five years ago. Applied science has brought not only prosperity, but greatly improved health to residents in Hong Kong.

The Barren Rock

When, in 1912, a cable from Hong Kong invited me to occupy the Taikoo Chair of Engineering in the University, the acceptance would never have been considered but for the friendships which had been made with Chinese engineering students in London. The cable came as a surprise, for at that time Hong Kong was just a name on the map in my mind, and my destiny seemed to be fixed in England. It was the intelligence, the respect for their teachers and the culture of those Chinese engineering students in London that caused me to make inquiries about Hong Kong. It was then that the amazing ignorance concerning Hong Kong of so many educated people in London, including myself, was revealed to me.

My first call was at the Colonial Office, where my problem was explained to a senior Civil Servant, who, about ten years later, became Governor of Hong Kong. When it was discussed with him he was told that there would result no financial advantage for me, if the invitation were accepted; he replied that it was foolish to consider the matter, but more information about Hong Kong was demanded. A pamphlet containing details of the price of rice, &c., was handed to me, with the depressing statement that it would be madness to take my wife and children into such a dangerous climate and surroundings. Hours were wasted in calculating the cost of commodities in Hong Kong, as the pamphlet listed it in dollars, which currency we believed had a value of 4s. 2d.; actually, the Hong Kong silver dollar at that time was worth about 2s. 1d. During

my residence there it reached a low price of 1s. 7d., and a maximum of (about) 6s. 6d. It is now worth about 1s. 2d., whereas the Chinese dollar runs into millions per pound sterling.

After many inquiries a reference book in the Royal Empire Society informed me that Hong Kong was "a barren rock," that malaria and other tropical diseases were prevalent there, and, in general, it presented a most depressing picture of the Colony, which now possesses the most beautiful scenery of its type on earth and a low death-rate for the British residents. After three voyages, by different routes, around the world, my belief is that, as was said some years ago by an American, "Hong Kong is a monument of British luck and pluck in the Orient," with the most beautiful harbour scenery it has been my lot to see. Much of the beauty had been created by the British, who covered the barren rock with trees and carried out extensive reclamation and public health works, but Nature provided the background.

At the end of a week of persistent inquiries in London, chance brought me into the office of Mr. J. H. Scott. He had spent several years in Hong Kong as local manager of the British firm known all over the Far East by the Chinese name "Taikoo." He was senior partner of the firm in London and had been instrumental in securing the endowment of £40,000 for the newly created university in Hong Kong. His son is chairman of the famous Glasgow shipbuilding company; perhaps the family connection with shipbuilding accounts for the large Taikoo Dockyard in Hong Kong and the fact that the £40,000 endowment was given with the condition that there should be a Chair of Engineering. When Mr. Scott, a far-sighted Scot, enthused concerning the advantages of applied science in the Far East, and informed me that the death-rate amongst the British in Hong Kong was lower than that in London, my outlook improved, although it was subsequently discovered that one reason for the low British death-rate in Hong Kong was that so many went "home" to die!

The Transformation of Hong Kong

When the island was ceded to Britain in 1841 there were about 5000 inhabitants, whose main occupation was piracy. To-day about three-quarters of a million people live a fairly righteous life on the island and a million in that part of the Colony situated on the mainland. During my residence Chinese pirates boarded, in disguise, steamers leaving Hong Kong; sometimes they were caught and hanged. In general, there was respect for law and order in the Colony.

In the early days (1841–47) the death-roll amongst the British residents, including troops, was appalling. It was due to malaria, typhoid, plague, &c. "Hong Kong" is translated as "fragrant streams," but until engineers organised a filtered and treated water supply system, typhoid caused many casualties. The "fragrant streams" on the island were polluted by primitive sanitation.

The astonishing transformation in the appearance of the island and the British territory (Kowloon) on the mainland, across the mile-wide harbour, has been largely due to huge reclamations of land from the sea and the levelling of numerous hills, the spoil being used for reclamations. On the island itself there is scarcely a building that is not either on reclaimed land or on land cut out of the hillside, the building being supported by a retaining wall. The island is about 11 miles long and, in spite of numerous inlets and peninsulas, is about 2½ miles wide. The hill, consisting mainly of excellent grey granite and decomposed granite, rises to about 1760ft above sea level. There have been projects for piercing the hill behind the City of Victoria (mainly situated on reclaimed land, with a population of about 400,000) in order to spread the population to the south side of the island, remote from the harbour. It was a good scheme, but it was never implemented, a reason given being that malaria was very prevalent on the south side of the island. The retort of the engineer was that malaria could be eliminated from the island. Malaria has been driven out of Cyprus, a much bigger island.

Transport

In about 1844 the first steamship from England arrived in Hong Kong. Until that date sailing vessels completed the voyage, via the Cape of Good Hope, in about three months. Steam ocean transport developed slowly and up till about 1860 the China tea clippers were famous as the fastest sailing vessels on earth. The construction of the Suez Canal enabled steamers, in 1912, to complete the voyage from London to Hong Kong in from five to six weeks. To-day air mail and passengers reach the Colony from London in about five days.

In 1912 there were two motor cars on the island; their route was restricted to a road just above sea level. Also, along this route, Dick Kerr and Co., Ltd., had equipped an electric tramline. This modern system of transport was, for a time, boycotted by the Chinese, due to the influence of owners of rickshaws and the numerous coolies who pulled and pushed the man-powered vehicles. During the strike a local British merchant advised me to purchase shares in this tramway company, but a cautious bank manager persuaded me not to gamble with my limited financial resources. The local Government broke the strike, after a few days, by the threat of taxation on Chinese shops along the route. The trams were soon crowded, the shares soared, and in 1919 the Hong Kong silver dollar reached the all-time supreme exchange rate of about 6s. 6d. If £1000 worth of tram shares had been purchased during the strike and sold out in 1919 and the dollar exchanged at the high rate for sterling, the sum realised would have been about £90,000. That result would have been due to the work of engineers and a gamble in currency. The latter has always been popular in the Far East, but during most of the nineteenth century the Chinese opposed engineering works. Gambling will probably remain for a long time a Chinese characteristic—floods, famines and rebellions in China make life uncertain—but there has been an intellectual revolution in Chinese official circles concerning engineering works, which are now strongly advocated. That revolution has been, to a great extent, due to the demonstration of the value of applied science in Hong Kong; the large numbers of Chinese who have been attracted to Hong Kong, from all parts of China, in order to secure a Western-style education, have realised the advantages of applied science. Dr. Sun Yat Sen told the students of the University of Hong Kong, about twenty-five years ago, that it was his residence in the Colony, when he was a student in the Hong Kong College of Medicine, that made him advocate engineering works in China.

In 1919 the local Government planned a much-needed system of motor roads, all over the island, including the difficult construction of roads up the hill to the Peak, where a number of residences had been constructed at elevations of 1000ft to 1700ft. A cable tramway, powered by an old boiler and steam engine, up to the Peak, had been in use for some years. The Government had insisted that the cable should be replaced by a new one at certain intervals. During the 1914–18 war new cables were not available. A request was made to me to investigate the strength of the cable. There was no record of how to do the job, but it was decided to pass the cable over a pulley which would compress down a heavy spring placed near the winding drum; the one cable was joined to two trams, one ascended while the other descended. By using a modification of a barograph the compression on the spring was recorded during the ascent of the tram. The angles between the cable, on each side of the compressed spring arrangement, were measured. During the tests soldiers filled the trams. The civil engineers who designed the cableway, assuming a coefficient of friction between the wheels and rail, had calculated the maximum pull on the cable at 12 tons. Our tests proved that the maximum pull was 5 tons. The Government allowed the cable to be used until the end of the war to the relief of residents on the Peak.

During the early part of this century an engineer, Sir Matthew Nathan, was Governor of the Colony for the usual period of five years. It was a general local belief that he was the most efficient Governor on record. He had a wide, straight motor road, about 2 miles long, constructed in Kowloon and roads made out to the border of Chinese territory, about 20 miles inland from the harbour, and he initiated other public works.

The Canton–Kowloon Railway traverses about 20 miles in British territory and 80 miles in the Province of Kwantung. About 11 million passengers were carried yearly during my residence in the Colony. There is also a great passenger and goods traffic between Hong Kong and Canton along the river. Many thousands of Chinese enter and leave Hong Kong every day.

A year after my arrival in Hong Kong there was a breakdown of a locomotive on the British section of the railway. The Government asked me to investigate the cause, a high official hinting that it was due to negligence of the British engineering staff. The crankshaft had fractured. By a coincidence my last five years in London had been, to a considerable extent, devoted to researches on combined stress. My report exonerated the British staff, giving the cause of failure as the poor design of the crankshaft. Various high Government officials, including the Director of Public Works, assured me that, as Sir John Wolfe Barry had been consulting engineer, my finding must be wrong. My reply was that if it were proved to be wrong my resignation would follow. Sir John confirmed the finding, to the annoyance of the Director of Public Works and the relief of British engineers employed on the railway.

Shipbuilding in Hong Kong

There are two large commercial dockyards, each employing about 5000 Chinese and a number of British engineers, draughtsmen, foremen, &c. In 1916 there commenced the building of ocean-going vessels of 12,000 tons. Since then ships and propelling machinery for others of that tonnage have been built, but the main business of these two yards is the repair of liners and cargo ships. Hong Kong is a centre for repairs of several well-known European lines—British, Dutch, American, &c.—and for the numerous ships distributing cargoes to ports all over the Far East. These dockyards were—probably still are—as well equipped with machinery as any in Britain.

The Royal Naval Dockyard employed, in my time, about 4000 Chinese. A Captain

(E.) and Commanders (E.) and other British personnel there and in all the local dockyards —for there are several other smaller establishments—have invariably expressed admiration for the skill, industry and patience of Chinese workmen.

It is notable that the largest liner in the world to be launched in 1949 is the P. and O. "Chusan" (24,000 tons) for the service between the United Kingdom and the Far East; the same firm's "Himalaya" was the largest in the world to be launched in 1948. In a record year Hong Kong headed the list of great ports of the world for the total amount of shipping entering the harbour. About twenty-five years ago Sir Maurice Fitzmaurice spent some time in Hong Kong obtaining data concerning the harbour which he included in a report containing valuable recommendations, some of which were carried out in my time.

Typhoons

From time to time terrific storms strike the Colony. During the early years of this century a typhoon reached Hong Kong without warning; 30,000 Chinese and a few British perished in the harbour. During my residence in 1937 an anemogram on the top of a building near sea level registered a wind velocity of 180 m.p.h. and then disappeared. The diameter of the typhoon may be 100 miles, the centre being dead calm. It may move along at about 10 or 15 m.p.h. There were few casualties in Hong Kong, but over 10,000 Chinese were drowned in adjacent seas in 1937.

During the 1937 typhoon four large liners, of over 20,000 tons, were thrown up on the rocks in the harbour and had to be salvaged. There were ample warnings of the approach of the typhoon, and the direction of the wind. The vessels dropped all anchors, had full steam ahead against the direction of the wind, but were wrecked. Large typhoon shelters had been built to protect native junks and sampans in the harbour. One of the most interesting investigations it was my fortune to carry out was that concerning the failure of plates on the leeward side of a large gasholder, with the result that several Chinese were burnt to death. My report was published; it caused new designs for gasholders. The main cause of the failure was excessive wind action.

The construction of large dry docks, sea walls, &c., and modern "go downs" (store houses of reinforced concrete) were carried out by qualified British civil engineers in Hong Kong. The maritime instinct of the British made them select Hong Kong from amongst the islands at the mouth of the Canton river, offered to them by the Chinese Government (who wanted to get foreign traders out of Canton), as it has such a splendid harbour.

Public Works Department

In the early days of the Colony the Royal Engineers were employed on Government work, but the local Government soon organised the P.W.D., engineers being recruited in Britain. Roads, reclamations, Government buildings, drainage, water supply, &c., came under the P.W.D. From the earliest days water supply for the island was a difficult problem; the rapid increase of the population often caused the enforcement of restrictions. There are now one large and three or four smaller reservoirs on the island, and a large reservoir was built in the 1930s at Shing Mun,* in the leased territory on the mainland. A pipe-line, laid on the bed of the harbour, carries the water across to the island. The Japanese invaders concentrated on the destruction of the water supply and their success in that work was a cause of the surrender at a date earlier than was generally expected.

On my arrival in the Colony the crude method of sanitation astonished me. Human excrement, known in the Far East as "night soil," was collected from every house soon after midnight. Coolies carried it from the houses in buckets; it was taken away from the Colony in barges. All over China "night soil" is used as manure, spreading typhoid and other diseases. Although, in 1939, flush closets had been installed in a number of houses occupied by Europeans, the "night soil" was collected from the great majority of houses. The limited supply of fresh water made it impossible to enforce modern sanitation; proposals to use sea water for the purpose were not accepted by the Government because of the expense.

An amusing sequel to the installation of modern sanitation for Chinese mechanics and coolies in the university workshops was the accidental discovery, after a few weeks, that "night soil" was being collected in the lavatories by an enterprising coolie, who used it in his vegetable garden.

Mention must be made of the great benefits which have resulted for the health of office workers due to the extended use of air-conditioning equipment. It will have a great effect on economic development in the tropics.

It is probable that the land system on the island is unique; it reveals the far-sightedness of a Governor of the early days, who introduced it. The few Chinese owning land were offered attractive prices; any unoccupied land became Government property. In a short time, with negligible exceptions all the land was owned by the Government. Any resident wishing to acquire land (invariably for building purposes) has to employ a local "authorised" (qualified) architect, who submits details of the site selected and the expenditure on buildings guaranteed to the P.W.D. If the site is not needed for water catchment, road improvement or military purposes, &c., an advertisement is issued, giving details of the site, the annual rent on a ninety-nine years' lease, and "the upset price" of the site, including the statement that an auction will be held at a certain date and time. The bidding for "the upset price" commences at the Government valuation. At times the result was astonishing; perhaps the most extreme case was when "the upset price" was 3000 dollars and the final bid was 30,000 dollars! Two wealthy Chinese had been informed by Chinese "Feng Sui" experts that the site was so lucky that long life and prosperity would come to the occupants of a house on that site. That story emphasises that, even amongst Western educated Chinese old superstitions survive. This system of land auctions is an important source of revenue for the Government owing to the great increase in the population of the Colony.

Technical Education

From 1912 to 1939 students in engineering in the university had theoretical and practical instruction of the standard of a university in England. At first it was difficult to find them appointments. Engineering progress in China was slow and European engineers were prejudiced against graduates with a better scientific training than they had received. In 1912 there were no British university engineering graduates in the P.W.D., but in 1939 there were several.

The most brilliant Chinese engineering graduate of those early years came to me after three years of experience on a railway in China. He said, "I have decided to give up engineering, there is no money in it. I am going into politics, that is where money is made." He had a most successful career in politics; his name is known all over China and he is now wealthy. His technical training was not wasted, for he has always used his influence to initiate and support engineering schemes. Moreover, he has been a true and trusted friend of the British.

Many of our graduates have played an important part in mechanised industry in the Far East, as well as in civil engineering work. They have always had a grievance that Chinese medical doctors profit more from their training than do engineers; the Malayan and Hong Kong Governments pay much higher salaries to Chinese doctors than to Chinese engineers. The doctors are aided by a professional organisation.

Soon after my arrival in Hong Kong it was my conviction that trade schools and technical institutes for Chinese mechanics were more urgently needed than universities; the old Chinese tradition that ensures the scholar greater respect than any other individual encouraged endowments for the Hong Kong University, but there was no response to my appeals for a local trade school. My only criticism of Chinese engineering graduates is that they overestimate the value of post-graduate degrees. China needs practical engineers. About twenty years ago the Salesian Brothers (Italian) inaugurated an efficient trade school in Hong Kong for homeless boys. Later the Hong Kong Government created a trade school. Our engineering staff agitated for a trade school in Malaya, which the Government at last created. To the surprise of Europeans, Malays requested admittance.

During the Japanese occupation university scientific equipment, &c., was sent to Japan and practically all of the woodwork in the university buildings was removed for fuel. Great efforts have been made since 1946 to re-establish applied science departments and students are now receiving instruction up to the old standard.

An official in London explained to me, during the war, that the Japanese were making aeroplane parts in the university workshops and requested me to show him, on the map, the site to be bombed. It had taken me years of agitation to obtain the money for the buildings and equipment.

Conclusion

It is true that "we here in the United Kingdom have held a position of tremendous importance in the Far East" and that "it is still of vital importance to us." In this country there are engineers who despair of applied science progress there, but the Chinese want machinery, &c. It would be a calamity if British engineers ceased to take an active interest in this enormous area of land and its immense population. Hong Kong was recently called by Walter Fletcher, M.P., a China merchant, "this lung of China," and "the most valuable thing which has been provided by the British Empire for China." This experienced ex-resident in the Far East is no pessimist about the future of British trade out there. In the eighteenth and nineteenth centuries British merchants in Hong Kong overcame great difficulties, at times suffering sudden death and heavy losses, at others reaping rich rewards for their enterprise and tenacity. Surely British engineers are undefeated in their purpose to serve humanity and to increase British prestige. They must retain their interests in the Far East. A century

* See The Engineer, January 22, 1937.

ago an American, Emerson, wrote: "What I heard first I heard last, the one thing the English value is pluck." Many years later another American wrote: "Hong Kong is a monument of British luck and pluck in the Orient." It is well to remember that successful engineers realise that luck is only another name for tenacity of purpose.

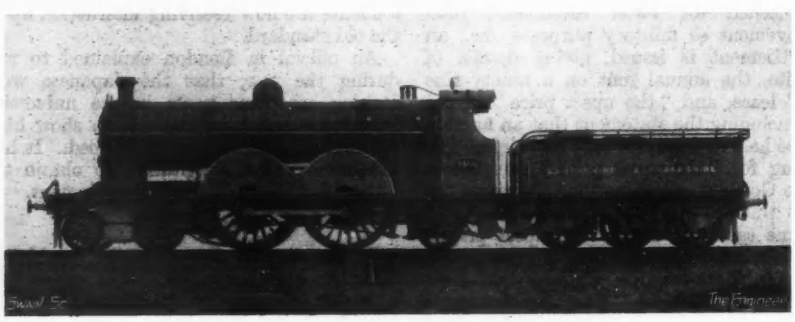
Two Notable British Locomotives

By E. C. POULTNEY, O.B.E., M.I.Loco.E.

GLANCING back into the past, the years from 1890 to 1900 may be said to cover a period of particular interest in British locomotive history for the reason that many steps then taken—as subsequent events have shown—were destined to be clearly reflected in modern practice. In the case of the two locomotives forming the subject of the present essay, this is perhaps particularly true, for both inaugurated important features characteristic of most recent designs.

Before entering upon the main theme of this article, we may take a quick look at certain locomotives built half a century ago and, in doing so, refer to THE ENGINEER of July 25, 1947, in which will be found the story of F. W. Webb's first four-cylinder compound engines of the "Black Prince" class.

While noteworthy from several viewpoints, their historic interest lies principally in the fact that they heralded the coming of the four-cylinder engine, which, a few years later, became more firmly established after the building of the "North Star" at Swindon, in 1906. In fairness, Manson's four-cylinder locomotive, No. 11, of 1897, should also be mentioned. This engine, for the Glasgow and South Western, and Webbs' four-cylinder simple "Iron Duke," for the L.N.W.R., came out almost simultaneously, the latter, as is well-known, being the forerunner of the numerous four-cylinder compounds subsequently built at Crewe. In 1898 Ivatt's famous "Atlantics" made their appearance, during May of that year. These engines, which formed the subject of another article contributed by the writer to the pages of THE ENGINEER, of July 16th last year, were distinguished as being the first of the "Atlantic" type, which, later, came into prominence on several railways and at the same time marked a step forward in the direction of larger and more powerful engines for passenger services, emphasised even more strongly in the following year, 1899, by Sir John Aspinall's 4–4–2 type engines, first built during that year. Following these engines, came Wilson Worsdell's "2001" class, the first of the 4–6–0 type specifically built for working express passenger trains. They must therefore not be confused with engines with the same wheel arrangement, designed by David Jones for goods traffic on the Highland line, and built by Sharp, Stewart and Co., in 1894.



ASPINALL'S 4-4-2 EXPRESS LOCOMOTIVE, 1899

SIR JOHN ASPINALL'S ENGINES

These very large locomotives, built to deal with express passenger trains over the "ups" and "downs" of the sinuous Lancashire and Yorkshire Railway, were in many respects remarkable. In wheel arrangement they followed Ivatt's example, but there the similarity ended. In boiler power they probably exceeded anything hitherto accomplished in British practice; certainly no locomotives of that time had such large boilers; in fact, these Horwich boilers were the first in Britain to have more than 2000 square feet of heating surface with one single exception—the Crampton-type engine, "Liverpool," of 1848. However, as Ahrons describes this as being nothing more than a "daring freak," we may perhaps be allowed to pass it by.* Though of the 4–4–2 type, the cylinders, unlike the Ivatt engines, were placed "inside" in conformity with Sir John's standards, which were also adhered to in other respects; thus, Joy's valve gear operating valves above the cylinders was retained, as were also the large driving wheels, 7ft 3in diameter, a distinguishing feature of the 4–4–0 type passenger engines, also designed and built at Horwich, in 1891. Actually, the new 4–4–2 engines, called the "1400" class, though very much larger, resembled in many respects the earlier 4–4–0 design, while, viewed together, a strong family likeness was very apparent.

The size of the boiler was without doubt the unique and attractive feature of these new engines. Some particulars will therefore be interesting.

Pitched with its centre 8ft 11in above the rails, the barrel, 4ft 9in and 4ft 10in diameter inside, was made up of two telescopic courses and contained 239 2in tubes with a length between tube plates of 15ft. The front tube plate was recessed rather far back in the barrel, in a manner similar to that adopted by Ivatt for his "Atlantics." From the tube plate to the centre of the chimney measured 3ft 10in, so that, although when viewed from outside a narrow smokebox might appear to be used, in fact, it was of quite considerable capacity and in this respect like the extended pattern. This smokebox design turned out to be rather a useful feature, as will be realised later on.

Referring now to the firebox, a design new to Horwich is seen, for, whereas former standards embraced a round-topped construction, the new design had the square-top Belpaire pattern, having a heating surface of 175·8 square feet, this not inconsiderable amount being made possible by the wheel arrangement, which permitted the fitting of a firebox with ample depth. The tube-heating surfaces were 1877 square feet and the total therefore no less than 2052·8 square feet. The grate area was 26·0 square feet and the working steam pressure 175 lb per square inch.

The cylinders were 19in by 26in, comparing with 18in by 26in for the 4–4–0 design, some of which, however, were fitted with the larger cylinders at one time, but it seems they were not satisfactory, being probably too large for the boiler. The real importance of the 4–4–2 locomotives is seen in the high boiler capacity in relation to that of the cylinders; or perhaps better stated, relative to the tractive force. It is this feature that gives to these engines such a prominent place in the annals of the development of the British locomotive. There were in all forty of these engines on the L. and Y., and of these the first twenty are of particular interest because they had steam-jacketed cylinders, a distinctly novel feature. The fitting of steam-jackets followed some experiments carried out previously at Horwich with another locomotive, in conjunction with the Research Committee of the Institution of Mechanical Engineers. The jackets were supplied with injector steam. On the whole the arrangement met with limited success.

Later a more important experiment was tried with five of these engines, involving the fitting of a superheater in the smokebox, and made possible by the design of the smokeboxes already mentioned.

This superheater consisted of a cylindrical shell, having tube-plates at each end. The tubes running through this cylinder were the same in number as those in the boiler, but of larger diameter, so that the boiler tubes could be withdrawn by taking them through the superheater tubes. Steam on its way from the boiler to the cylinders passed through the cylindrical superheater fitted with baffles to direct the flow of steam over the tubes, through which the hot gases of combustion passed on their way to the chimney. The superheating surface was 439·49 square feet.

This was one of the early experiments with superheater equipment, though, in common with other smokebox superheaters, the results were not important. Mention may be made of the fact that when first built these engines were fitted with the American swinging-link type of bogie, later changed to the more usual Adams sliding pattern. Readers more particularly interested in these noteworthy engines are referred to an excellent sectional drawing, which clearly showed the jacketed cylinders, published in THE ENGINEER, March 17, 1899.

WORSDELL'S SIX-COUPLED LOCOMOTIVES

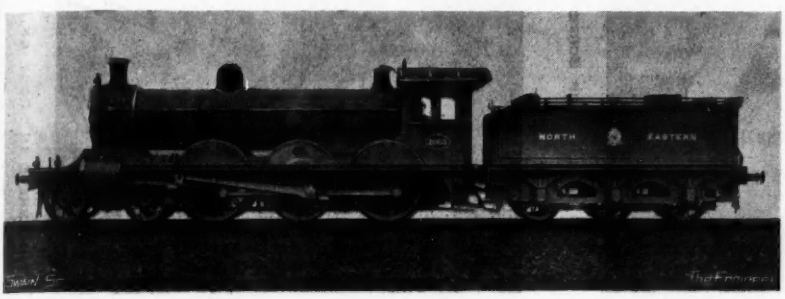
Closely following the appearance of Aspinall's large passenger engines for the L. and Y., Wilson Worsdell built for the North Eastern Railway the first British six-coupled

*This engine had a boiler with 2290 square feet of heating surface and a grate area of 21·5 square feet. It was built for the L.N.W.R. by Bury Curtis and Kennedy in 1848.

4–6–0 type engines, intended for express passenger service.

These engines, which were first constructed during the latter part of 1899, formed a striking contrast with the L. and Y. design in more ways than one. Beyond the difference in wheel arrangement, a point of special interest is seen in the relative sizes of the driving-wheels, for, while the L. and Y. engines had exceptionally large coupled wheels, the size adopted for the Worsdell design was definitely small for the fast East Coast Joint Stock express passenger services.

The diameter of the wheels for the North Eastern engines was only 6ft 1½in, whereas at that time the 4–4–0 passenger engines on



WORSDELL'S SIX-COUPLED LOCOMOTIVE. 1899-1900

the line had 7ft 1in wheels, which may be said to have been a favourite size on most railways. The use of relatively small-diameter driving-wheels for fast running had not, in fact, met with much success; for instance, S. W. Johnson, on the Midland, after having somewhat unhappy experiences with 6ft 2½in wheels for 2–4–0 type locomotives, decided to use nothing smaller than 6ft 6in drivers for express engines, and ultimately adopted coupled wheels of either 6ft 9in or 7ft diameter, the latter predominating.

Further, Worsdell had himself built two 4–4–0 passenger engines earlier in 1896, with wheels no less than 7ft 7½in diameter. These were, however, more or less experimental. With this single exception, the L. and Y. 4–4–0 design of 1891 and the 4–4–2 engines with their 7ft 3in wheels, had the largest coupled wheels ever used, being 1in more than Brittain's "Caledonian" 4–4–0 type, of 1877, having 7ft 2in drivers. During more recent years, with the advent of piston valves in conjunction with the short, straight cylinder ports now in evidence, the diameter of the driving wheels is of less importance than formerly. The greatly improved steam flow through the cylinders, in contradistinction with that attainable with slide valves and the rather tortuous "S" ports associated with their use, enables modern engines with relatively small wheels to attain high speeds readily. Further, the advantages offered by improved cylinder design have been considerably assisted by the use of high pressure superheated steam.

Referring now to Worsdell's ten-wheelers, a few detailed particulars will be interesting. The boilers used had a total of 1768 square feet of heating surface, of which the firebox surface contributed 130 square feet, the balance of 1638 square feet being in the 204 2in tubes, 15ft 4½in long, between the tube-plates. The grate area was 23 square feet. The 20in by 26in cylinders were outside the frames with valves inside, operated by Stephenson's gear. Slide valves were fitted to the first few engines, but the rest had piston valves of the Smith pattern, though the cylinder ports still had a certain amount of curvature and were therefore not so direct as in present-day practice. These engines had not been long in service before another class came out, in all respects similar except that the coupled wheels were increased in size to 6ft 8in, which no doubt made them much more suitable for fast running.

Those with the smaller wheels were relegated to secondary duties and, a few years later, commencing in 1903, Worsdell's very large Class V "Atlantics" worked the principal main line passenger traffic. Ultimately, after about 1911, Sir Vincent Raven's three-cylinder 4–4–2 type engines took over all the East Coast Joint fast passenger services, which they successfully conducted for many years.

The main line between York through to Edinburgh (Waverley) presents few difficulties so far as gradients are concerned, with the exception of a fairly stiff pull-up to Grant's House, from Berwick, 15 miles, mostly at 1 in 190 and 1 in 200, going north, and in the reverse direction the engines have to face the Cockburnspath bank between Innerwick and Grant's House, where for about four miles the gradient is at 1 in 96.

The introduction of six-coupled engines for so easy a road seemed somewhat unnecessary, and the fact that even the later 4–6–0 engines having the larger wheels gave place to the 4–4–2 type seems to show that such was actually the case. So far as the L. and Y. is concerned, though no doubt the operating conditions differed materially from those on the North Eastern, the engines had to tackle a more difficult road and, in due time, Hughes' 4–6–0 four-cylinder locomotives were employed for the heavier train services.

Principal Dimensions, Lancashire and Yorkshire and North Eastern Express Passenger Locomotives

Railway and Type	L. and Y. 4–4–2	N.E.R. 4–6–0
Cylinders, diameter and stroke, inches	19 by 26	20 by 26
Driving wheels, diameter, inches	87	73½
Boiler steam pressure, lb per square inch	175	200
Heating surfaces, square feet:		
Tubes	1877·0	1638·0
Firebox	175·8	130·0
Total	2052·8	1768·0
Grate area, square feet	26·0	23·0
Engine weight, tons	58·75	66·0
Weight on coupled wheels, tons	35·0	49·5
Engine and tender, tons	89·4	105·0
Wheel-base, engine, feet and inches	27ft 9in	26ft ½in

However, Sir John Aspinall's fine four-coupled engines of 1899 showed the way to the large boilers to which we have grown accustomed, and in like manner Wilson Worsdell's engine, "No. 2001," portrayed a favourite express-type of the present day.

The N.E.R. engine, illustrated, is of the same class as "No. 2001," from which it differs by having a rather larger cab.

For comparative purposes the short tabulation above sets out the leading dimensions of these two famous locomotive designs of fifty years ago.

A Canadian Sulphate Pulp Mill

THE new 23,000,000 dollar 300-ton bleached sulphate pulp mill of the Longlac Pulp and Paper Company, Ltd., subsidiary of the Kimberley-Clark Corporation, at Terrace Bay, Ontario, Canada, is now in operation. This mill is laid out for streamlined, straight-line production. Pulpwood is delivered to a jack-ladder and moves into the wood yard, and then by conveyor to the wood room through the barking drums to chippers, screens and digesters, and finally to the washing, bleaching and pulp drying building. There is a modern recovery unit and causticising plant and the bark from the pulpwood is utilised to furnish part of the power required. Less than a mile from the mill is an Ontario hydro plant, which supplies power for the mill. This installation includes two generators, each of 27,500 h.p.

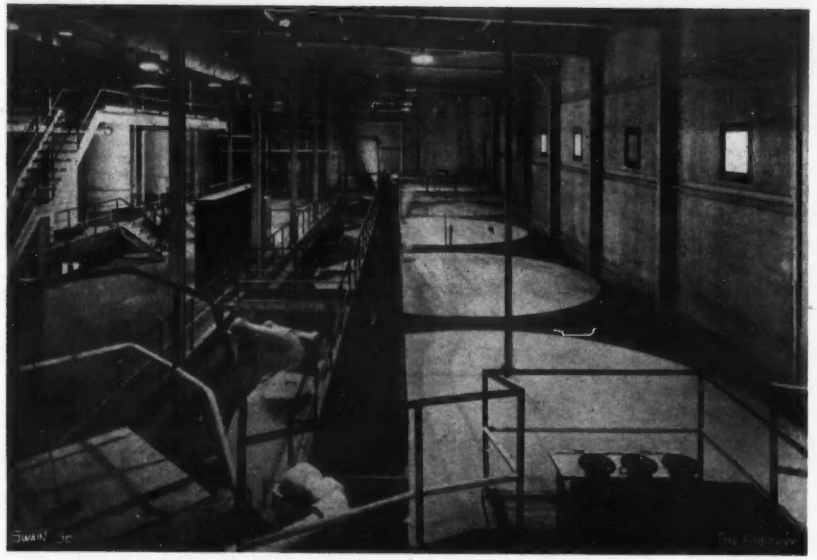
Pulpwood is moved from the water's edge to the mill by a 1600ft conveyor, then either into the mill or into the wood yard over another 1425ft conveyor. Here it is handled by a twin-arm stacker, which deposits it into one of the six separate piles, each of which is 100ft high and has a capacity of 25,000 cords. The bark handling system delivers the bark from the barking drums over a conveyor system to the six bark presses and then to the boiler-house where it is burned in a dutch oven. The jack-ladder will handle 8ft or 16ft wood, which is cut to 4ft lengths and then conveyed by a belt conveyor to the wood room, and then either to the stacker in the wood yard or direct to the chipper. Three steel barking drums with a capacity of 65 cords per hour have been installed, and from them wood is delivered by a sorting belt either to storage or to chippers. From the latter it goes to three Tyler screens, then to the chip bins.

There are six digesters. The pulp is blown from the digesters into blow tanks in connection with the blow heat recovery system, then to a three-stage pulp washing system consisting of consistency regulators, stock meters, pre-knotter and rotary vacuum washers. There are two parallel lines of three washers in each line. The pulp then goes into stock chests, then to the screen head box, then to the fourteen primary flat screens. The rejected stock goes over six secondary flat screens and the rejects from the secondaries to four more flat screens. The accepted stock is sent to two rotary vacuum deckers. Then the stock goes into five stock chests with a total capacity of 60 tons.

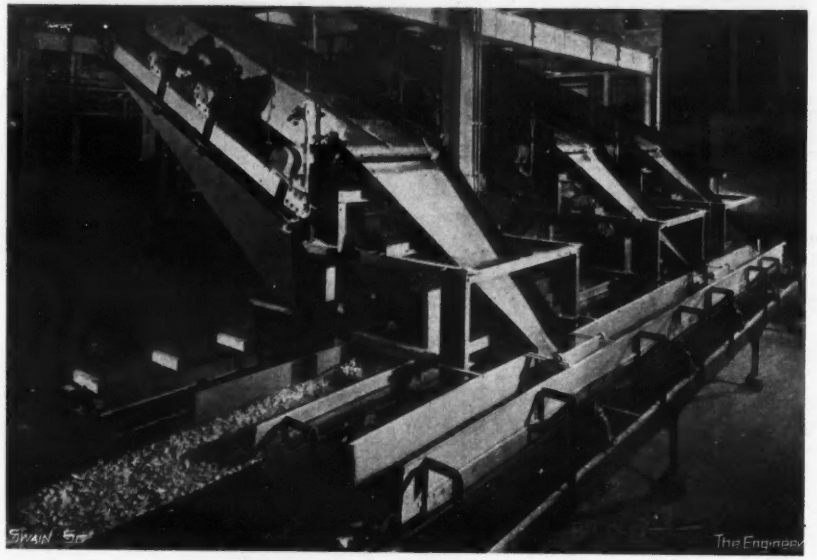
The bleaching system consists of one chlorination stage, two caustic stages, and two hypo stages, all continuous. Each stage consists of reaction towers, dump chests and vacuum washers.

The pulp drying system starts at the machine chests where the pulp is sent from the bleaching system. From the machine chests the bleached pulp is pumped by stock pump to a consistency regulator and into a head box and then through two 136in Kamyr wet sections consisting of cylinder moulds, first and second presses, and pre-dryer. Next the pulp passes through two 136in Flakt dryers equipped with Briner economisers, and then through slitters and lay boys. Thereafter the pulp bundles are carried over a Matthews conveyor system and auto-

SULPHATE PULP MILL AT TERRACE BAY, ONTARIO, CANADA

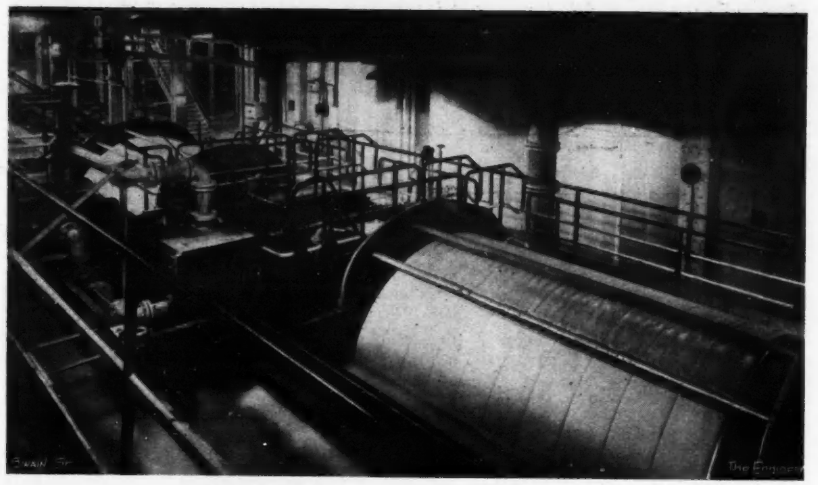


OPERATING FLOOR OF CAUSTICISING BUILDING



CHIP SCREENS

OPERATING FLOOR OF BLEACHERY



THICKENERS IN FRONT OF STOCK SCREENS

matic scales to the hydraulic baling press. The pulp bundles are finally taken into the pulp storage building.

Recovery System

The recovery unit is the largest combustion engineering unit in operation at the present time. It is estimated that its production is in excess of 350 tons of pulp and 150,000 tons of steam per hour. In this recovery system, the black liquor from the washers goes to a six-body multiple effect evaporator and is burned in the recovery furnace. The recovery furnace includes cascade evaporators. The chemicals are recovered from the flue gas by a Cottrell precipitator. The smelt from the recovery boiler is dissolved and pumped as green liquor to a continuous re-causticising system, then through the green liquor classifier and dregs washer. Next, the green liquor is treated with burned lime in the lime slacker and the white liquor goes through three causticising tanks, then to the white liquor clarifier and white mud washer.

The white liquor from the white liquor clarifier passes to the cooking liquor mixing tank in the digester building where it is mixed with some black liquor for cooking liquor. The white mud goes to the vacuum filters and then to the oil-fired rotary lime kiln, measuring 8ft by 300ft. This kiln is equipped with 50ft of chain section. At present it is oil-fired, but it is being equipped to use producer gas. The kiln is supported at five points on trunnions, is driven by a four-speed motor and is equipped with auxiliary I.C. engine drive for use in the event of power failure. It was put on high foundations to eliminate the necessity for a pit at the hot end. Hood draught is controlled automatically by the induced draught fan. Forced draught is manually controlled.

The control instrumentation at the Longlac mill extends to all parts of the production process. The digesters are equipped with cooking liquor mixing tank level controls, temperature and pressure recorders and time pressure controllers as well as temperature-pressure relation controller. The blow heat recovery system has a Foxboro temperature control.

In the pulp washing process there is a two-pen level recorder used on the black liquor tanks, indicating flow recorders on the black liquor line with recording flow meters on the last stages, while recording tachometers are used on the stock meters. In the screen room level recorders are used on the stock chest.

In the pulp bleaching process, the stock meters are equipped with recording tachometers, while the stock chests have level recorders. Each bleaching stage has a pulp mixer equipped with a temperature controller. The tower has a level recorder. The temperature controller is a two-pen recorder with one in the pulp mixer and one in the tower. The level recorder is also of the two-pen pattern, with one bubble pipe in the lower and one in the tower dilution chest. A temperature controller is used in the hot water heater for hot water to the showers. Fisher and Porter "flowraters" are used on the chemical lines to meter the chlorine, bleach, liquor and caustic. A continuous caustic dilution system is used to reduce the density of the caustic to approximately 100 grammes per litre and to 40 grammes per litre. Republic Flow Meter Company's density transmitters are used for this purpose. Other instruments are also used, such as pressure recorders and indicating pressure controllers.

On the evaporators the Foxboro control system is used. In the causticising process level controls are used. Allis-Chalmers control equipment is used for the lime kiln.

Accompanying illustrations shows typical parts of the plant.

Sheet-Cutting Machine Room

Boiler Plant

In the boiler plant there are two boilers, each having 85,000lb per hour capacity, which is sufficient to supply steam requirements at the mill. One boiler is for coal alone and the other for burning both coal and bark. In addition, the recovery unit has a capacity of 130,000lb per hour. By these means the steam supply for the mill can be provided under normal operating conditions by the recovery unit and the bark burning boiler without the use of coal.

On the ground floor of the boiler-house there are three pulverisers, three feed water pumps, an ash disposal system and six air compressors. On the operating floor there are exhausters for blowing the coal from the pulverisers to the boilers, feed water heater, feeder for bringing the coal to the pulverisers and an instrument panel for boiler control. There is also a suspended bunker for the coal. On the top floor there is a conveyor to transport the bark to the wood preparation building, an induced draught and a forced draught fan for each boiler, and a coal handler, coal elevator and spreader conveyor and three feed water tanks.

The electrical requirements for the mill are supplied from the adjacent Hydro-Electric Commission power station at 132,000V through two 10,000-kVA transformers, which transform the current to 69,000V. There are seven unit sub-stations, each 2000kVA, which again transform the current from 69,000V to 550V for the motors less than 350 h.p. The motors over 350 h.p. are fed directly from the feeder. The new feature of this distribution scheme is the use of the sub-stations, which will result in cheaper distribution of the power and also supply the power where it is needed.

There are more than five hundred motors in the mill. They are used in every part of the process beginning with the wood yard and ending with the pulp drying and storage.

In connection with the mill a model town has been built at Terrace Bay, on the north shore of Lake Superior, to house four hundred workers.

Engineering responsibilities on the project were shared. Kimberley-Clark Corporation's Engineering Department drew up the flow diagrams, selected equipment, and did much of the detailed design. Stadler and Hurter, of Montreal, were consulting engineers on various aspects of plant lay-out and equipment. Surveyor, Nenniger and Chenevert were the structural designers.

Transport Users' Consultative Committees for Scotland and Wales

It is announced that the Minister of Transport has appointed Transport Users' Consultative Committees for Scotland and Wales. The Chairman of the Scotland Committee is Mr. Neil S. Beaton, and the Secretary is Mr. J. Reid. The offices of the Committee are at 23, Waterloo Place, Edinburgh. The Chairman of the Committee for Wales is Lieut.-Colonel H. Edmund Davies, K.C., and the Secretary is Mr. W. R. Davies. The offices of the Committee are at the Railway Executive, Queen Street, Cardiff. These Committees are established under the provisions of Section 6 of the Transport Act, 1947, and they follow the appointment under that section of the Act of the Central Transport Consultative Committee for Great Britain on December 19th last. In addition to the independent Chairman, the Transport Users' Consultative Committee consists of sixteen or seventeen representatives of agriculture, commerce, industry, shipping, labour and local authorities, with members nominated by the Minister of Transport and the British Transport Commission. The Committee may consider any matter—including charges—affecting the services provided by the British Transport Commission. In particular it must consider any such matters as may arise from representations made by users of those services or are referred to the Committee by the Minister. The recommendations of the Committee will be notified to the Central Transport Consultative Committee for Great Britain and the British Transport Commission.

Bows and Arrows.—We learn from Tube Investments, Ltd., that a new British export trade in steel bows and aluminium steel-tipped arrows is being developed by Accles and Pollock, Ltd., of Oldbury, Birmingham. Following successful trials by American archery experts of the British bows, special consignments have been sent to the United States; sales have also been made in many overseas countries. The new British steel bows require over 200 processes, including fourteen heat-treatments, in their manufacture. The wall-thickness of the tapered tube from which they are made is controlled to within one-thousandth of an inch, and its flatness to three-thousandths of an inch, while the weight of the arrows does not vary by more than five grains. Although the manufacturing process is mechanised as far as is possible, a high degree of skill is required from the craftsmen who operate the machines.

Metallurgical Topics

Metallurgical Congress and Symposium

THE outstanding metallurgical events of the present month have been the Symposium on the Refining of Non-Ferrous Metals, arranged by the Institution of Mining and Metallurgy, and the meeting of the fourth Empire Mining and Metallurgical Congress in London and Oxford, and later at other centres. The Symposium was prefaced by the second Sir Julius Wernher Memorial Lecture on "The Effect of Impurities on the Properties of Metals," delivered at the Royal Institution by Dr. C. H. Desch on July 6th, and on the following two days nineteen papers on many aspects of the refining of metals were read and discussed. In the following week two sessions, H and I, of the Empire Congress, were devoted to Metallurgy and Metallurgical Industries, and at these twelve papers were presented.

The purpose of papers read at such assemblies is not to give an account of original work or to put forward new ideas, but to describe present practice and the latest developments in the special field with which each author is best acquainted. Much of the information contained in the papers is not yet to be found in textbooks, but remains scattered in papers and discussions published in scientific and technological journals until gathered up and presented in a concise and comprehensive form by experts in the various subjects. The collected papers of the Symposium and of the Congress will therefore form a valuable addendum to any modern textbook, and make readily available to those who may be only indirectly interested up-to-date information on a variety of special subjects.

EXTRACTION METALLURGY

In many respects, within the field of extraction metallurgy, the papers communicated to the Congress and to the Symposium may be regarded as complementary, the distinction being that the Congress papers dealt with the whole or any part of the extraction process, while the Symposium papers described more particularly the ultimate refining operations. Thus, from Mr. Frank Green the Congress received "Lead Sintering Practice at Port Pirie," and the Symposium "Refining of Lead and Associated Metals at Port Pirie, South Australia"; "The Electrolytic Zinc Industry," by Mr. H. Hey, and "The Zinc Smelting Industry in Great Britain," by Mr. S. W. K. Morgan, were read at the Congress, "Refining of Zinc," by Mr. Stanley Robson, was read at the Symposium; "Extraction, Alloying and Fabrication of Magnesium," by Major C. J. P. Ball, went to the Congress, "The Refining of Magnesium," by Mr. E. F. Emley, to the Symposium; "Some Modern Developments in Copper Pyrometallurgy," by Mr. W. B. Boggs, was presented at the Congress, while the Symposium received three papers on the Refining of Copper.

Though the Congress papers quoted above give much information of engineering interest about plant and equipment, the Symposium papers followed the course of production to the stage at which the metal becomes available to the user, and for that reason many of them may be of greater engineering interest. Not all the papers, however, at either meeting were confined to a discussion of methods of extraction.

SOME SYMPOSIUM PAPERS

The first paper read at the Symposium was on "Spectrographic Control in the Refining of Metals," by Mr. D. M. Smith. The advantages and limitations of spectrographic analysis were clearly brought out and illustrated by examples of its application to five common metals, and the fact that spectrographic methods of analysis are not "absolute," but require standards for calibration purposes, was emphasised. In spite of this much was said in the discussion of disagreement between different laboratories, no doubt using different standards and different techniques, in analytical results on a given sample, with a tendency to attribute this disagreement to the use of the "spectrographic method." Fortunately, Sir Arthur Smout was able, from his wide experience of the use of spectrographic methods by I.C.I. (Metals) and at the Ministry of Supply, to reassure the company as to the value of spectrographic control in production and in rapidly and accurately checking uniformity of supplies with minimum demands on the time of analytical chemists.

The metals in common use dealt with at the Symposium were copper, lead, zinc, tin, aluminium and magnesium. In addition, there were papers on cobalt, tungsten, zirconium and some of the rarer metals, as well as on the precious metals, gold, silver and platinum, and one paper on products of the aluminothermic process. Both electrolytic and fire refining of copper were dealt with. The reinstatement of fire refining in Great Britain was described in a paper by Mr. H. J. Miller. Apart from the elements sulphur, cadmium and zinc, which are removed by volatilisation and pass away in the furnace gases, impurities are removed in the course of fire refining by their oxidation and absorption into the slag. Improved furnaces, better refractories and a more highly developed casting practice have brought fire refining up to a high state of efficiency; but on account of the extent to which fuel and labour costs have risen, it will need strenuous efforts for Britain to retain her present activity in refining.

A paper on "The Refining of Lead and Associated Metals at Port Pirie, South Australia," by Mr. F. A. Green, contained details of the continuous lead-refining process in operation there. A brief outline of the sequence of the refining operations is as follows:—

(*a*) Base lead bullion from blast-furnace smelting of sinter is drossed for removal of copper, the copper dross being smelted in a reverberatory furnace to produce matte and speiss for sale to the Electrolytic Refining and Smelting Company of Australia, Port Kembla, for production of electrolytic copper.

(*b*) Arsenic and antimony are next removed in a single, small reverberatory furnace through which lead is pumped at a regular rate adjusted to meet supply conditions. Arsenic and antimony are oxidised to a leady slag by compressed air agitation of the lead bath.

(*c*) The softened lead flows continuously through a desilverising kettle, and gold and silver are collected in a molten zinc alloy which forms the upper layer of a conjugate solution system. Lead is discharged from the kettle through an overflow siphon pipe, the position of which controls the level of metal in the kettle.

(*d*) Zinc remaining in the lead after desilverising is removed in the dezincing furnace, a small reverberatory furnace identical with the softening furnace and likewise using air agitation to promote rapid oxidation.

(*e*) The refined lead is cast into 56 lb bars on two Newnam casting wheels and handled by electric trucks to storage areas in stacks of sixty bars each.

(*f*) Zinc alloy containing precious metals passes through the successive operations of retorting, cupellation and electrolytic parting, to produce refined silver and gold and, at the same time, to recover lead and zinc present in the original alloy.

The antimonial slag, zinc dross, &c., are, of course, economically and appropriately dealt with at the various stages of the process. The refined lead produced contains 99·993 per cent of lead. The average grade of market silver is 999·8 fine with a gold content of 0·02 oz per ton. A by-product of the process is cadmium which enters the lead smelter system in lead concentrates and in zinc plant residues; the average grade of the refined metal produced is not less than 99·97 per cent cadmium.

This paper elicited warm tributes to the outstanding advance which the Port Pirie plant represents. Apart from its compactness, a feature of the continuous process is the extent to which definite operating conditions can be imposed on each section by a central metallurgical control, and the duties of those operating the plant largely become a checking of the imposed conditions.

In a paper on "Refining of Zinc," Mr. Stanley Robson described refluxing methods of distillation which give metal of purity 99·996 per cent zinc, whereas typical electrolytic zinc contains 99·97 per cent, though recent developments of the electrolytic process, due to U. C. Tainton, have brought the zinc content to over 99·99 per cent. This appears to be the limit attainable by electrolytic methods, though by distillation with increased refluxing or by vacuum distillation a close approach can be made to the absolutely pure metal. The cadmium associated with zinc in many ores may be refined by repeated distillation or refluxing to give a metal containing over 99·99 per cent of cadmium.

Another metal obtainable commercially in a high state of purity is aluminium. This was dealt with in a paper on "Refining of Aluminium," by Mr. J. Waddington. The only true refining processes so far used on a large scale are the three-layer electrolytic refining processes in which either a chloro-fluoride or an all-fluoride electrolyte is employed. These give metal of more than 99·99 per cent purity from the ordinary commercial metal, and have been modified recently to produce metal of the same high purity starting from low-grade scrap. They are not satisfactory processes for the upgrading of scrap as they require large amounts of electrical energy and are, therefore, expensive. Catalytic distillation in the presence of halides has been suggested as a means of obtaining refined aluminium, and it is possible that this may eventually lead to a practical process. The physical chemistry of the method has been investigated by Dr. P. Gross, whose paper on "Catalytic Distillation of Aluminium" was read at the Symposium.

Electrolytic processes have been used for the purification of magnesium scrap, and very pure magnesium can be prepared for experimental purposes by distillation, but the paper on "Refining of Magnesium," by Mr. E. F. Emley, dealt with the development of fluxing processes, such as the "Elektron" procedure, and with chemical purification, both by direct exchange with fluxes and by precipitation processes. A table of approximate impurity contents of commercial magnesium is contained in the paper. It would appear that a purity exceeding 99·8 per cent is normally obtained. The author does not give figures for the magnesium content of the products he describes; but according to the Dow Chemical Company a typical analysis of the product of the electrolytic process carried out on specially purified magnesium chloride shows 99·95 per cent of magnesium.

Much of the discussion of the papers presented at the Symposium was concerned with details of the various processes described and was not of general interest. Some of the contributions, however, were very effective in revealing the underlying principles which linked the subject matter of many of the papers together. This was noticeably so in the remarks of Mr. A. R. Powell on the chemical aspects, and of Dr. F. D. Richardson on the thermodynamical aspects, of a number of processes which they discussed. It is quite clear that the free-energy/temperature relationships to which Dr. Richardson several times drew attention form a reliable guide in the recognition of reactions and equilibria which are likely to be important in metallurgical processes. Thermodynamical studies, such as those of Dr. Ellingham and Professor Dannatt on metallic oxides and sulphides, and of Dr. Richardson on a wide range of substances of interest in iron and steel making, introduce important unifying principles into the study of metallurgical processes. Such studies might be extended with advantage in the direction of obtaining new and more

accurate thermal data and in their range of application.

It is impossible in a short space to convey more than an impression of the proceedings, but this would not be complete without mention of the interest aroused by some reminiscences of Dr. S. W. Smith, especially those referring to the earliest days of the Goldschmidt process for the reduction of oxides by aluminium and its demonstration during a lecture by Sir William Roberts-Austen at the Royal Institution. The paper on "The Aluminothermic Process," by Mr. T. Burchell, showed how things had developed since those days; though it is interesting to note that Mr. Burchell claims that Goldschmidt saw the process in 1898 in a laboratory in City Road, London, where Vautin and some English collaborators had carried out experiments and had produced crude ferro-vanadium.

The papers read at the Symposium are expected to be published, with the full discussion, by the Institution of Mining and Metallurgy at an early date. Reference will be made to some of the Congress papers in a later issue.

(To be continued)

Age-Hardening Nickel Alloys

NICKEL alloys are outstanding for the way in which control can be kept on elastic and dilatometric properties by modification of composition and heat-treatment. In a paper with the above title, F. C. Ochsner* has recently described the composition and properties of high-expansion, low-expansion and constant-modulus Ni-span alloys. The combination of controlled physical constants and the high strength obtainable by age-hardening, or cold work followed by age-hardening, renders these alloys suitable for a wide range of uses.

Perhaps the most interesting of the series is Ni-span C, in which good mechanical properties may be combined with a constant Young's modulus and modulus of rigidity over a useful range of temperature. This is achieved by the addition of chromium and titanium in suitable proportions to a 42 per cent nickel-iron alloy. Typical properties of Ni-span C are shown in Table I. The temperature coefficient

TABLE I.—*Properties of Ni-span C (Precipitation-Hardening Constant-Modulus Alloy)*

Nickel, 42 per cent; chromium, 5·5 per cent; titanium, 2·5 per cent; carbon, 0·06 per cent

	Annealed	Hardened 675° C	50% cold-worked and hardened 675° C
Limit of proportionality	6·7	29·0	49·1
0·2% yield strength ...	15·6	51·3	80·4
Tensile strength, tons per square inch... ...	40·2	80·4	89·3
Elongation per cent on 2in.	40	18	7
Brinell hardness number	145	345	395
Modulus of elasticity, $\times 10^6$, lb per sq. in. ...	24	26·5	27·5
Modulus of rigidity, $\times 10^6$, lb per sq. in. ...	10	10	10
Approx. thermo-elastic coefficient, $\times 10^6$ per deg. Fah.	−15	− 5	0

of elastic modulus varies about a zero value, according to the chromium plus titanium content and to the treatment (Fig. 1). Ni-span C is used for parts of instruments which must maintain constant elastic properties with change of temperature; for example, precision springs, tuning forks, calibrating rings, diaphragms for pressure-sensitive instruments, such as altimeters, &c. Its use may frequently eliminate the need for temperature-compensating devices, such as are necessary for some purposes with copper alloys. For example, under a given load, a beryllium-copper spring will give an increase of deflection of about 4 per cent over the temperature range −45 deg. to +65 deg. Cent., while the increase in deflection of a Ni-span C spring over the same temperature range would be 0·2 per cent. To produce a 4 per cent increase in deflection would require a temperature change of over 260 deg. Hysteresis is also very small. The suitability of Ni-span C for corrugated diaphragms in pressure responsive devices has been investigated by R. I. Jaffee, E. I. Beidler and R. H. Ramsey.†

In other cases the requirement is a particular value of coefficient of expansion. Ni-span-Hi is a precipitation hardening alloy with a coefficient of expansion similar to that of an austenitic steel. Ni-span-Lo (in various grades) has a coefficient of expansion slightly greater than that of Invar; and, in the cold-worked and aged condition much better mechanical properties. The Ni-span-Lo alloys all contain

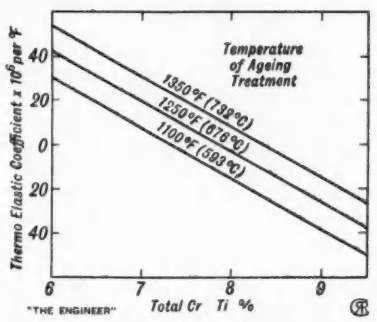


FIG. 1—*Effect of Composition and Treatment on the Temperature Coefficient of Elastic Modulus*

about 2·4 per cent of titanium with carbon 0·06 per cent, various nickel contents and the balance iron. The coefficient of expansion varies with the nickel content in the manner shown in Fig. II. The properties of Ni-span-Lo 42 are given in Table II. It is used, among other

TABLE II.—*Properties of Ni-Span-Lo 42 (Precipitation-Hardening Low-Expansion Alloy)*

Nickel, 42 per cent; titanium, 2·4 per cent; carbon, 0·06 per cent

	Annealed	Hardened	50% cold worked and hardened
Limit of proportionality	8·9	29·0	49·1
0·2% yield strength ...	17·9	53·6	73·7
Tensile strength, tons per square inch... ...	40·2	73·7	87·1
Elongation per cent on 2in	32	14	5
Brinell hardness number	135	325	380
Modulus of elasticity, $\times 10^6$ lb per sq. in. ...	21·0	22·0	22·5
Coefficient of expansion $\times 10^{-6}$ per deg. Fah...	0–430° F., 1·8 0–1000° F., 5·8		

applications, for arbors for carboloy-faced rolls in rolling mills, and as a backing for carbide-tipped tools, because its expansion is close to that of cemented tungsten carbide. By varying the nickel content a range of alloys is obtained having thermal coefficients of expansion suitable for a wide variety of applications. The technical publications of Henry Wiggin and Co., Ltd., and of the Mond Nickel Company also give particulars of these alloys, and in addition of the nickel-cobalt-iron alloy, known as Nilo K, containing nickel 29, cobalt 17 and iron 53 per cent approximately, and specially suitable for sealing to hard glass.

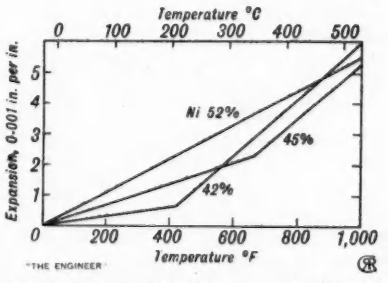


FIG. 2—*Effect of Nickel Content on Coefficient of Expansion*

Fatigue Strength and Notch Sensitivity

FROM time to time statements have been made implying a direct relationship between notched-bar impact value and resistance to fatigue. There has never been any justification for assuming a connection between the two, and it is difficult to understand how the idea arose; but the existence of such a relation, though not recognised, is often the subject of a question. Less directly, the question arises as to whether metallographic constituents that improve the localised toughness in a notched-bar test will also be of benefit in resisting the initiation and propagation of fracture in a member subject to a large number of cycles of stress.

Work recently reported by T. J. Dolan and C. S. Yen* was designed to study the extent to which differences in microstructure of steel affect the fatigue properties and Charpy impact value in various steels, heat-treated to the same level of hardness.

The steels investigated had the following compositions, and each was tested after receiving the heat-treatments shown below:—

Composition	S.A.E. 1045, per cent	S.A.E. 3140, per cent	S.A.E. 2340, per cent
Carbon	0·44	0·37	0·40
Silicon	0·21	0·18	0·28
Manganese	0·75	0·75	0·74
Sulphur	0·021	0·030	0·020
Phosphorus...	0·014	0·017	0·019
Nickel	—	1·33	3·48
Chromium	—	0·65	—
Heat-treatment	**Deg. Cent.**	**Deg. Cent.**	**Deg. Cent.**
(1) Water quenched from...	830	—	—
Oil hardened from ...	—	830	788
Tempered at...	650	700	650
(2) Oil hardened from ...	830	—	—
Air cooled from	—	830	788
Tempered at...	565	565	370
(3) Oil hardened from ...	—	—	788
Quenched in lead at 388 deg. Cent.	—	—	388

Tests were made of tensile properties, hardness, Charpy impact values, and flexural fatigue properties of both notched and unnotched specimens.

The principal conclusions drawn from an extensive series of tests were:—

The rapidly quenched group of steels showed higher energy absorption and much lower transition temperatures in the Charpy test than the steels more slowly quenched. The austempered samples, isothermally transformed in the lead bath at 388 deg. Cent., had an intermediate temperature of transition from the tough to the brittle type of fracture.

The fatigue notch-sensitivity of the slowly quenched steels was in each case greater (i.e., there was greater reduction of fatigue stress caused by a stress raiser) than for the same steel which had been rapidly cooled.

No direct functional relationship was evident between the concepts of notch-sensitivity in a fatigue test and the notch-sensitivity shown in a Charpy impact test. A rough correlation was found for the same material at the same level of hardness and tensile strength, but the relationship became inaccurate when different materials were compared.

The Charpy impact test develops a higher rate of strain at peak stress than the fatigue test, and fracture under impact is not dependent on the cumulative effects developed during the repetition and reversal of load which are of importance in leading up to failure by fatigue. Fatigue notch-sensitivity was often smaller (i.e., there was a higher endurance limit for notched specimens) when the impact figure was poor. Even at the same strength level there was no evidence of a direct relationship between the notch-sensitivity of the various steels tested, as indicated in fatigue tests and as determined by Charpy impact tests.

* *Product Engineering*, October, 1948, Vol. 19, page 126.

† *Amer. Soc. for Metals*, Preprint 16, October, 1948.

* "Proc.," Amer. Soc. Testing Materials, 1948, Vol. 48, page 664.

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THE VALUE OF A UNIVERSITY

AT the recent inauguration ceremony of the new University of Nottingham Lord Trent, who had just become its first Chancellor, seems to have been hardly fair, in one of his remarks, to the virtues of technicians. "It is not," he said, "the function of a university to provide industry with technicians, but to be a seat of learning where the habit of exact thinking is inculcated." But if, indeed, it should be expostulated that at least among the higher grades of technicians "exact thinking" is a very necessary quality, the distinction the new Chancellor intended to draw between a "special" and a "general" education is clear enough. A university should aim less to provide each student with information than to train his brains to clear and candid methods of thought, so that in after-life to whatever field of endeavour he may turn, even if it be one that he had not in mind at that time, he will find in his intelligence an implement well sharpened to his purpose.

It is, of course, no new thought that Lord Trent so expressed. Yet, we believe, the principles upon which university training are based bear constant repetition. For in these days when any man whose academic education is complete must perforce sooner or later specialise in one thing or another there is a continual tendency to exaggerate the importance of mere knowledge. Nor, indeed, can teachers themselves be found wholly guiltless of that charge. In the training of engineers, for instance, certain subjects are regarded as constituents of a curriculum so essential that whatever other changes are suggested they cannot be omitted, an idea apparently based upon the conviction that those subjects impart knowledge rather than that they have a particular use for training the mind. The fundamental object of education is, of course, not to give its recipient information, but to train him how best to use the intellect he has inherited. A century and more ago Latin was particularly favoured as a study for the developing mind. Nor does it lack its advocates to-day. But those who aim to enter technical professions no longer favour Latin. It is argued that, though, indeed, the object of education is to train the mind in ways of thought, surely there is no reason, in doing so, why some useful information should not also be imparted. Few nowadays whose work lies in scientific subjects would fail to give support to that very reasonable argument. Yet it is as well to realise that the line of thought involved is not without its dangers. Those who teach Latin to their scholars can have few illusions that knowledge of a dead tongue will prove of much eventual value to their pupils. There can be no confusion about the objects of such an education. It is to discipline and train the mind in precision of thought. But once let a course of instruction become informative and it grows only too easy to confuse the object with the means! Emphasis begins to be laid rather upon the desire to provide useful information than upon the need not only to inculcate a quality of honesty in thought, but also to encourage a subtle, critical, questing attitude of mind. It is a virtue of university organisation that such a descent is scarcely possible. For students of many and varied subjects brought together into a single community learn to value their companions not only for their knowledge, but for the use they can make of it, and for their ability to grasp or criticise a point bearing upon a subject not their own; to value, that is, qualities of mind at least as much as qualities of knowledge, and to learn in time the truth of Sir Thomas Browne's dictum, "that a good cause needs not to be patron'd by passion, but can sustain itself upon a temperate dispute."

It is, we think, all the more necessary to maintain a clear perception of the purpose of a university in that, since the war, there has been much discussion of means for improving and extending "technological" education. Where is this education to be provided? If it is to be given at all we do not think the universities are the right bodies to undertake it. Their part predominantly should be to educate those technical students who may become the administrators and executives of industry. For "the higher a man rises in industry," Lord Trent truthfully remarked, "the less the technical qualifications count and the more valuable are the human qualities of character, courage and vision." It is true that "character, courage and vision" do not lose their value even for men whose life's work remains amongst the technicalities of engineering. Honesty in criticism, the courage to oppose prejudice or authority or to challenge the accepted view, the imagination to visualise how much of value may follow from a particular line of action, and judgment in the choice of courses, methods and materials, are required by the research worker and the designer as well as by the executive. Yet it is, we think, true that those whose training has been too solely technical often find, when the familiar ground of science is left behind that they are all at sea. For instead of calculating from observed facts to assured conclusions they are then asked to weigh evidence, to judge character and to found action not upon scientific certainties, but upon probabilities and sometimes even hopes. For an executive has to deal with human material and, in distinction to those concerned with technicalities, seldom has solid technical or scientific principles upon which to ground an argument. Here, then, character, courage and vision are essential to useful activity. It is, of course, very doubtful whether those qualities can be inculcated by teaching. Yet we believe that in a broadly based community such as a true university provides there is a ground favourable for their early germination and cultivation.

New "technological" colleges have been suggested as a means of providing the large numbers of trained entrants to industry that will be required in the future. But would such colleges, whose outlook would surely be more narrowly technical than that of universities, provide ground equally favourable for the early germination of qualities of character, courage and vision? Is it possible that they could in some distinctive way provide an education as broad as that of a university? We do not believe they could. It would thus become necessary, were such colleges set up, to attempt to distinguish at a certain stage between adolescent students whose minds would benefit from a university education and those whose minds, though of equal quality, seemed better attuned to the acquirement more narrowly of high technological abilities and who might become the technical rather than the administrative leaders of industry. But is it possible to make such a selection so early? And is it really desirable that the technical leaders of industry should have experienced an education any less broad than that experienced by administrative and executive leaders? But maybe we are misunderstanding the meaning of the term "technologist." Perhaps it is intended to cover administrative as well as technical grades. But if that is so the less broad education to be provided by a technological college could only be regarded as inferior to that given by a university and the students of such a college must necessarily carry a lower status. We doubt whether it is the real desire of the protagonists of technological colleges that the old students of those colleges should be regarded as "second best" to university graduates.

ANTECEDENTS AND PRECEDENTS

LIBERTIES may be taken with all save a few of the formalities that control the activities of committees. The agenda may be by-passed or wrecked by irrelevance, the minutes despite their sanctity may be "taken as read," respect for the chair may be submerged in local bickerings and private

whisperings. But whatever may be the lapses of a committee, in one respect it will never be caught napping. Never will it forego its right to have a precedent. Let some daring spirit advance a proposal that has not already been canvassed, and forthwith, as sure as the equinoxes, a voice will be heard demanding a precedent. Then are the pages of memory hastily turned over and the minutes searched in feverish haste. The Committee is divided. On one side are the sticklers for traditional practice, on the other those who care not a hoot for tradition—save when it will serve their turn. But a precedent there must be. One party is resolved to accept the merest shadow, the other is resolved that nothing discoverable shall satisfy them, and the chairman is placed in the awkward position of having to declare for one party or the other—to uphold the traditionalists or to waive the precedent.

The precedent complex is a common affliction of the narrow mind; it reveals itself, as we have seen, at the committee table, but it is always lurking in our inner consciousness, and scientists are no more free from it than lesser men. Our thoughts are embedded in pre-ordained grooves by education, and in the course of the years the grooves become ruts out of which we scramble only into grave difficulty if we do not elect, for our comfort's sake, to remain in them. The armchair of custom is dear to us all. And the worst of it is that we are so enslaved by traditional knowledge, it has become so much a part of ourselves that we are—most of us—unable even to *think* outside the established codes. Thus it was when Einstein exploded a bomb in Newtonian physics. Thus it may be, one of these fine days, when some philosopher who has freed himself from traditions and precedents blows the theory of the conservation of energy sky high, or tears to tatters the principles of thermo-dynamics! These are great things and it is amongst lesser that precedents and antecedents lie most heavily upon ordinary people. If we desire to move in a new direction we begin by documenting ourselves as fully as possible upon the antecedents. Inevitably, that sets us off with a bias. We build upon the relics and ruins of the past. When we should be advancing boldly upon some new venture we begin by fitting our shoes into the footprints of our predecessors. From this human weakness none, or only here and there one or two, can escape. It is the way the mind works. Just as all patentable inventions are, officially, "improvements" on something already known, so are our thoughts, technical or lay, built up upon antecedents or precedents.

Let it be acknowledged, however, that this respect for precedents is not without inestimable value. It is the inertia which checks violent oscillations of thought and which stabilises our actions. Slow progress from the good to the better is more desirable than constant revolutions in human affairs, and it may be that in the realms of technology the slow advance by petty changes is, in general, more efficacious than a sudden leap forward. If so, we may thank goodness that, in any case, it is quite unavoidable, as Uncle Penstermon told Mr. Polly on his wedding day its "nat'ral—like poaching or drinking, or wind on the stummik. You can't help it, and there you are."

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

LOCOMOTIVE INTERCHANGE TRIALS

SIR,—Mr. Holcroft, in his letter published in your impression of July 22nd, stresses the importance of the quality of coal that will be available as locomotive fuel in the future, and seems to suggest some rather definite knowledge on this point should be had as a prelude to the design of the boilers for the new standard engine types now receiving attention. I am wondering to what extent this is really important and, if it should be held as a governing factor, how long it would take the nationalised mining industry to give any information on the matter. In practice are there such large differences in the qualities of coal which may be expected to be available? From time to time the railways have made numerous tests with different kinds or qualities of coal mined in different parts of the country; further, such tests have usually been carried out with one particular locomotive representative of a standard type. So far as I am informed, no difficulties have been met in making such trials, and while some coals have been shown to be better than others so far as evaporative power is concerned, it has in general been quite possible to fire sufficient of the low-grade coal to get through the trip. Mr. Holcroft has contributed to your pages some account of coal trials made on the Southern Railway and Mr. E. S. Cox gave some information of a similar kind when discussing a paper I read before the Institution of Locomotive Engineers in 1943. It may also be observed that very extensive coal trials were carried out on the Furness Railway some years ago using one engine without any alterations for all tests.

The remarks made on the question of the size of grates seem to invite some comment. For my part, I strongly support the designers of the proposed standard engines on this point. Grates should always be as large as possible. How much fuel has been thrown away in the past by trying to overdo the power output per square foot of grate area? Anyway, it depends upon how one looks at the matter, for if the engines are intended to adorn the tracks at locomotive terminals no doubt a small grate may be advantageous; if, on the other hand, they are intended to do a good and economical job of work on the road, then ample grate surface is, I think, desirable.

One other point in remarking on the desirability of large grates. The Executive probably have a fairly shrewd notion that they are more likely to be served out with bad rather than what they would consider good coal. If the designers of these boilers play safe they will provide ample grate areas, shaking grate bars and good-sized hopper ashpans fitted, when necessary, with drenching gear. Additionally, it may well be worth while making provision for the fitting of mechanical stokers on the larger locomotives should this be found desirable in the future, as may well be the case.

Finally, does not the fact that standard G.W.R. engines were able to operate with Welsh and the various other kinds of coal obtainable at Wolverhampton and Tyseley or Birkenhead, rather refute my old and valued friend's argument? E. C. POULTNEY

Haverstock Hill, N.W.3
July 26th.

IMPROVEMENTS TO LEITH DOCKS.—An expenditure of over £400,000 on new works during the next four years has been approved by the Leith Dock Commissioners. Work has been progressing for some time on extension and improvement of the facilities at Leith Docks, and the volume of trade passing through the port has been gradually increasing since the end of the war.

Electricity Supply Research Council

THE British Electricity Authority has decided to set up an Electricity Supply Research Council, the chairmanship of which has been accepted by Sir Harold Hartley, F.R.S., Chairman of the British National Committee and International Executive Council of the World Power Conference and a former Chairman of the Fuel Research Board. Other members who have accepted invitations to serve are Sir Edward Appleton, F.R.S., Principal and Vice-Chancellor of the University of Edinburgh; Professor F. E. Simon, F.R.S., Professor of Thermodynamics, Oxford University; Sir David Brunt, F.R.S., Professor of Meteorology, Imperial College, South Kensington; Professor H. W. Melville, F.R.S., Professor of Chemistry, Birmingham University; Sir Geoffrey Taylor, F.R.S., Yarrow Research Professor of the Royal Society; Mr. V. A. Pask, M.I.E.E., M.I.Mech.E., Chief Engineer of the British Electricity Authority; and Mr. C. W. Marshall, B.Sc. (Eng.), M.I.E.E., Deputy Chief Engineer (Research) of the British Electricity Authority. Additional nominations will be made to represent the Electricity Boards. The terms of reference of the Council are: "To advise the Central Authority and Area Boards on specific problems relating to electricity supply; to keep under review matters affecting the supply of electricity and to advise the Central Authority and Area Boards on programmes and planning of research carried out over the whole field; and to make recommendations to the Central Authority on research which the Council considers it desirable to initiate."

Colonel Development Corporation

THE annual report of the Colonial Development Corporation for the year ended December 31, 1948, has now been published by the Stationery Office. It also covers the period before the passing of the Overseas Resources Development Act in February, 1948, when the Secretary of State requested Lord Trefgarne as chairman-designate to prepare plans for the new organisation. The report mentions the difficulty of sending heavy equipment to a Colony. Thus, the cost of sending an agricultural tractor to a site in Nyasaland amounts to nearly 40 per cent of the f.o.b. price, while constructional steel sent to Uganda has incurred transportation costs approaching 100 per cent of the f.o.b. price. During the year under review the chairman, Lord Trefgarne, Sir Frank Stockdale, the deputy chairman, and Mr. H. Nutcombe Hume, and Sir Miles Thomas, have paid personal visits to fields of operation. The work has been divided into fifty-seven divisions and projects affecting fifty-seven different territories were under consideration at December 31, 1948. In British Guiana gold dredging has been started, and timber concessions in the Manaka, and adjoining areas, are being worked. In the Turks and Caicos Islands, salt production and refining is to be reorganised. In the Falkland Islands sealing is to be revived, and seal liver oil, residue meal and fertiliser meal produced. In Gambia, in West Africa, tests have been made with U.S. and European crawler tractors, and sawmills have been set up for timber production. Tung oil for the paint industry is to be produced in Nyasaland, in Central Africa, and Manila hemp in North Borneo. The Equipment Division of the Corporation reports on shortages of structural steel, wire and sheet steel, electrical generating plant, heavy engineering plant, agricultural equipment and cement plants. The Corporation has decided to establish pools of equipment and maintenance workshops in its main overseas centres of activity and a Central Equipment Depot in the United Kingdom. The most serious shortage is, it is stated, in the heaviest type of crawler tractors, none of which is produced in the United Kingdom. American machines have been tried, and an Italian model tested. Steps are now being taken to produce a model in this country.

Behaviour of Cast Steel at Elevated Temperatures*

No. I

By A. E. JOHNSON, M.Sc., A.M.I. Mech. E.†

SUMMARY

THE purpose of the investigation was to examine the nature of the creep properties of a nominally isotropic 0·17 per cent C cast steel at temperatures of 350 deg., 450 deg. and 550 deg. Cent., and under general systems of stress.

Some eighty tests consisting of pure tensile, pure torsion and complex stress creep tests (the latter under various combinations of simple tensile and torsion stresses) have been performed on the 0·17 per cent C steel at 350 deg., 450 deg. and 550 deg. Cent. The results of these tests have been analysed and equations for the stress strain relations for the steel, over the temperature range concerned, have been derived.

(1) *Introduction.*—An appreciable amount of work, both theoretical and practical, has now been carried out on the problem of creep of metals under complex stress systems at elevated temperatures.

The majority of the theoretical treatments have been based on modifications of the original theory of plastic flow suggested by St. Venant[1]‡ in 1870, with the experiments of Tresca as a basis, although one theory (that of R. W. Bailey) is based on an assumption of different relations between stresses and creep strains from those assumed by St. Venant. The arguments for these theories are given in Papers 3 to 8 listed in the bibliography, and a critical summary of them is given in an earlier paper by H. J. Tapsell and the author.[2]

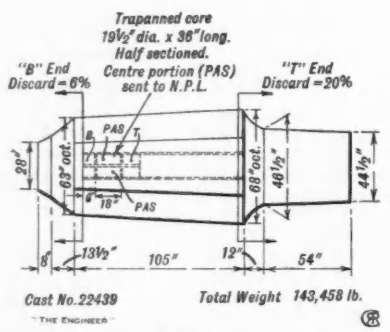


FIG. 1—*Diagram of Ingot of 0·17 per cent C. Steel, Showing Position of Blocks (PAS) Used in the Research*

The experimental work done to test the truth of these theories is not so far very extensive, and there is not yet sufficient evidence available to justify the adoption of any one theory for a wide range of materials and working temperatures.

Such experimental work as has been performed is briefly commented upon below.

It has been generally assumed that by addition or subtraction of a suitable hydrostatic stress, complex stress systems as a whole can be replaced by an equivalent system of simple tension combined with simple torsion stress, which will give creep characteristics of a corresponding nature, and the general problem of creep under complex stress systems is most simply studied under systems of this character. Accordingly, such systems and also the relatively simple system of internal pressure with or without axial stress have formed the mode of all investigations so far.

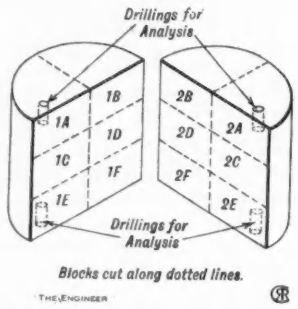


FIG. 2—*Method of Cutting Up and Marking the Blocks*

The work of R. W. Bailey on a 0·115 per cent C steel and on a 0·45 per cent C steel at 480 deg. Cent. under combinations of tension and torsion, and on lead tubes at room temperatures under internal pressure and axial load led him to the conclusion that in general a relatively complex relation existed between creep stress and strain, in which the creep rates were dependent on power functions of both the shear strain energy and the maximum shear stresses of the complex stress system.[4]

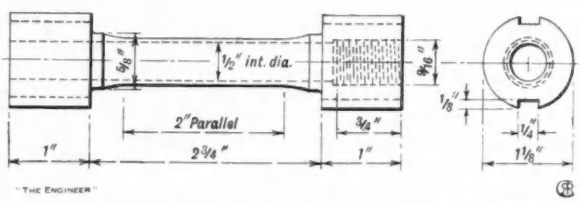


FIG. 4—*Form of Test Piece Used in Pure Torsion and Complex Stress Tests*

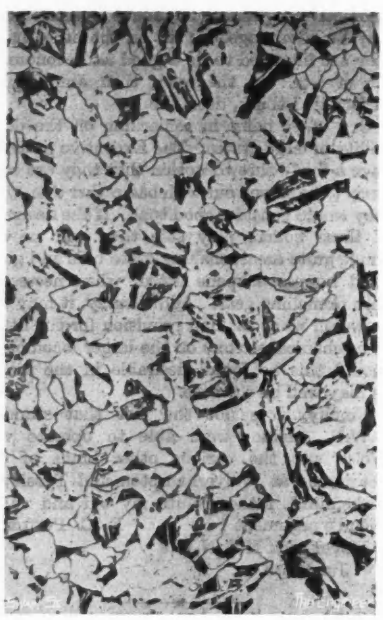


FIG. 3—*Photo-Micrograph of a Section of the Material*

Work by H. J. Tapsell and the author on a 0·17 per cent C hot rolled steel at 455 deg. Cent.[2] and by the author on a 0·5 per cent Mo steel at 550 deg. Cent. (results unpublished) indicated that over the range of stresses investigated the creep rates were well represented by a power relation with a function of the maximum shear stresses, but no evidence appeared that a shear strain energy function was involved. The relations obtained in these tests indicated that neither of the materials tested was isotropic as judged by the criterion of creep, and that the form of terms in these relations other than those involving the maximum shear stresses could not therefore be stated with confidence. Further, the range of stresses examined was somewhat restricted and it is possible that the formulæ obtained were particular cases of more general formulæ, which would have involved a strain energy term.

Jamieson[9] made torsion and tension creep tests on lead tubes at 25 deg. Cent. and comparing the tensile and torsion relations with those computed on the basis of an assumption of modified St. Venant theory found only very approximate agreement.

Everett and Clark[10] carried out tests in tension and torsion of 0·5 per cent molybdenum steel at temperatures of 800 deg. and 1050 deg. Fah. for periods varying between 1000 and 1500 hours, comparing values of the characteristic exponents of the material measured in tension with those computed from the torsion tests on the basis of an assumption of the modified St. Venant theory. Agreement appears to have been good.

F. H. Norton[11] made experiments on the creep of tubular specimens closed at the ends and subject to internal pressure, and additionally pure tension tests on what were nominally the same steels as were used by Everett and Clark at 900 deg. Fah. and 1050 deg. Fah. The periods of test varied from about 2600 to 6400 hours. Very approximate agreement with modified St. Venant theory was obtained. Analysis of the results of Everett and Clark, and of Norton by E. A. Davis[12] on the basis of the octahedral plane relations indicated considerable difference between materials used, possibly due to condition of isotropy.

A critical survey of experimental work so far carried out has been made, in the light of the various theoretical treatments, by J. Marin in his recent book "Mechanical Properties of Materials and Design" (McGraw Hill).

(2) *Nomenclature.*—See footnote on page 128.

(3) *Particulars of Steel Tested.*—The material was received from the English Steel Corporation in the form of two blocks of semi-circular section 18in diameter, and of length 19½in, trepanned from an ingot of acid open-hearth steel. Details of the ingot, and of the core trepanned from it, are given in Fig. 1.

The two semi-circular blocks were cut longitudinally in half and then transversely at points one-third, and two-thirds the way down their lengths. The general scheme of cutting is shown in Fig. 2. One-third of

* Report J/T 137, The British Electrical and Allied Industries Research Association. The full title is "The Behaviour of a Nominally Isotropic 0·17 per cent C Cast Steel Under Combined Stress Systems at Elevated Temperatures."

† National Physical Laboratory.

‡ Bibliography will appear at end of concluding article.—Ed. THE E.

the block was used at each of the three temperatures of the investigation.

Sulphur prints taken of the block were uniform in character and showed no appreciable segregation in any portion of the material.[14]

Macro etches showed a characteristic "as cast" structure for the material.

Specimens for chemical analysis from the ends of the blocks (as indicated in Fig. 2) gave results as indicated below :—

Element	Position			
	1*A*	2*A*	1*E*	2*E*
C	0·17	0·16	0·17	0·16
Si	0·19	0·21	0·20	0·19
S...	0·026	0·026	0·027	0·027
P	0·034	0·032	0·033	0·033
Mn	0·64	0·64	0·63	0·64

Evidently the material supplied was satisfactory in regard to uniformity of chemical composition throughout.

A grain size for the material, small compared with the thickness of the tube-wall section, was obtained by heat-treating specimen lengths, cut from the block, for three hours at 950 deg. Cent. followed by air cooling, then fifteen minutes at 930 deg. Cent., followed by air cooling, and, finally, a stress-relieving treatment of three hours at 575 deg. Cent., with furnace cooling.[15]

A photo-micrograph of a section of the material thus treated is shown in Fig. 3.

Creep tests on solid specimens prepared from material cut longitudinally, and in a radial and a circumferential direction, from the block showed almost identical creep properties at a temperature of 450 deg. Cent., and a stress of 6 tons per square inch, up to 150 hours, and corresponding tests on tubular specimens gave the same results. The behaviour of the specimens was independent of their longitudinal position in the block.

The indication of these tests therefore appeared to be that the block, from the point of view of creep, was in a satisfactory condition of isotropy.

(4) *Form of Specimen Used.*—The tubular test piece used was of the form shown in Fig. 4. It was 0·5in internal diameter and had a nominal wall thickness of 0·020 ±0·0005in over a 2in parallel portion. In making a specimen, a blank was first machined down to within $^1/_{32}$in of the largest diameter, after which the specimen was drilled through. The ends of the specimens were then turned down to size, and the centre portion reduced by light cuts to $\frac{11}{16}$in diameter. The specimen was bored to within 0·0005in of finished size and one end was internally screwed. Final machining and polishing of the central portion was carried out with the specimen on a mandrel and keyways were cut in the ends. The specimen was finished by lapping the hole to correct size. Measurements of the external diameter and of the wall thickness of each specimen were made at numerous positions along the parallel portion.

A measure of the degree of oxidation to be expected in the tests at 350 deg., 450 deg. and 550 deg. Cent. was obtained by suspending pieces of the steel in furnaces maintained at the respective temperatures for periods of one and seven days. Measurements indicated that the oxidation over seven days at 350 deg. Cent. was inappreciable. At 450 deg. Cent. it reached a maximum value of about 0·0005in on a double surface after one day, and was not appreciably further increased up to seven days. Since in each test at 450 deg. Cent. the specimen was heated up overnight, and took one day at least to reach a steady correct temperature, the wall thickness throughout each test was taken as being 0·0005in less than the measured initial thickness. This was allowed for by making the wall thickness 0·021in, as against the nominal 0·02in originally intended for the specimens.

Similarly, at 550 deg. Cent., oxidation reached a maximum of about 0·002in on a double surface, after one day, and was not appreciably further increased up to seven days. The wall thickness of the specimen during test was in this case assumed to be about 0·002in less than the measured initial thickness, and was allowed for by making the wall thickness 0·023in.

As a further check, the specimens at the end of each test were sectioned longitudinally and the oxide surface removed, and measurement made of the actual wall thickness, and the stresses of the corresponding test corrected.

All test pieces used were taken longitudinally from the block.

(5) *Description of Test Apparatus.*—The main features of the testing machine and extensometer used in the tests have been described in a previous paper.[2] The machine has since been modified in detail, the main change being that a furnace split horizontally at its middle section is now used, and controlled by an individual thermostat. By this means the gradient on the specimen is reduced to less than 2 deg. Cent. at all temperatures while the temperature is controlled within ±1/4 deg. Cent.

(6) *Experimental Work.*—Only one creep test was carried out on each specimen.

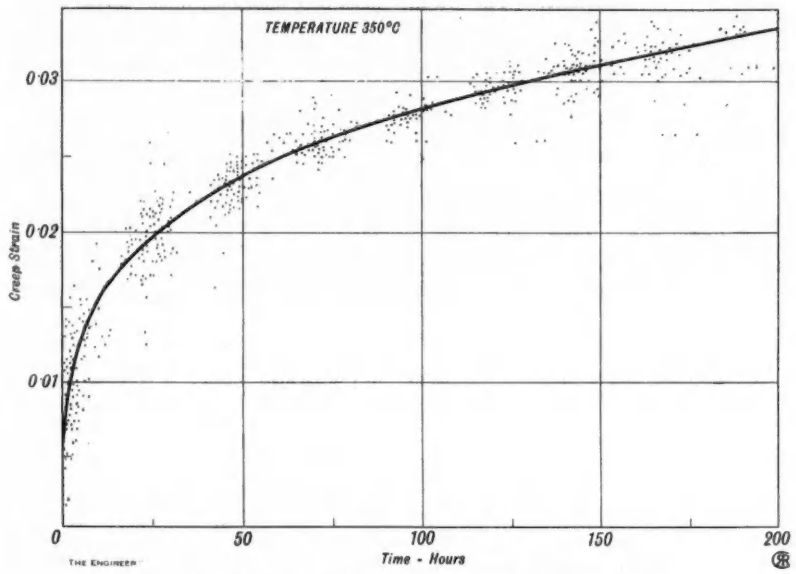


FIG. 5—*Composite Creep Strain-Time Curve for All Stress Systems*

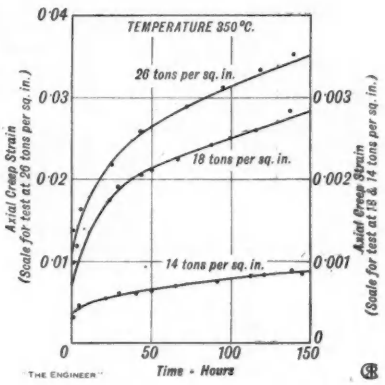


FIG. 6—*Creep Strain-Time Curves for Pure Tensile Tests*

The tests lasted about 150 hours (except in the case of certain pure tensile tests continued to the period of minimum creep rate), readings of creep strain being made at frequent intervals during the first day and thereafter at intervals of a day. For the majority of tests the stresses were chosen to give a range of creep rates in the direction of maximum principal stress, varying between 10^{-5} and 10^{-7}in/in/hour at 150 hours, but several tests at 450 deg. and 550 deg. Cent. were at stresses giving rates between 10^{-4} and 10^{-5}in/in/hour.

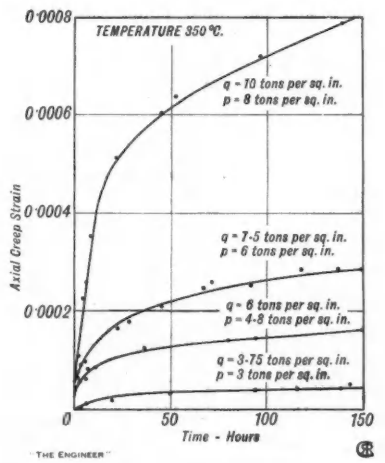


FIG. 7—*Axial Creep Strain-Time Curves Under Stress Ratio* $q/p = 1·25/0·1$

The creep rates in the three directions of principal stress were computed from the measured axial and circumferential creep rates by means of the formulæ :—

$$C_1 = C_a + \frac{C_c}{2}[\sqrt{(p/2q)^2+1} - p/2q]$$

$$C_2 = C_a - \frac{C_c}{2}[p/2q + \sqrt{(p/2q)^2+1}]$$

$$C_3 = C_c p/2q - 2C_a.$$

The derivation of these formulæ is given in the Appendix of paper[2] of the Biblio-

graphy. The octahedral shear creep rate was computed from the formula :—

$$C_o=\frac{2}{3}[\Sigma(C_1-C_2)^2]^{\frac{1}{2}}.$$

This corresponds to the octahedral shear stress :—

$$\sigma_o=\frac{1}{3}[\Sigma(\sigma_1-\sigma_2)^2]^{\frac{1}{2}}.$$

Between five and eight pure tensile tests were made at each temperature. In view of the high cost of tubular specimens, the majority of these tensile tests were made on solid specimens. Some were made on tubular specimens, however, to gather information on the degree of isotropy exhibited by the material.

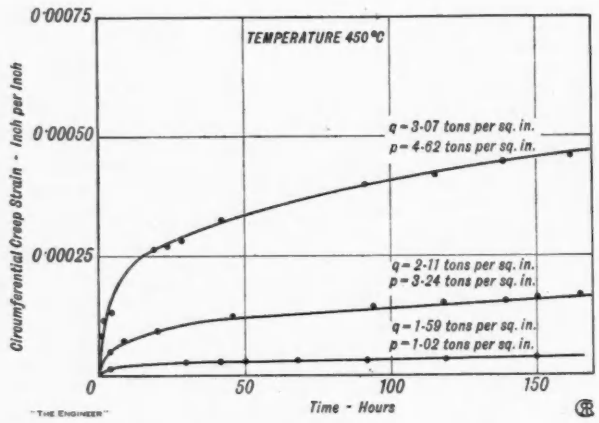


FIG. 8—*Circumferential Creep Strain-Time Curves Under Stress Ratio $q/p=0\cdot65$*

At 350 deg. Cent. seven pure torsion tests were made, four tests under the ratios of torsion to tension stress 2·5, five tests under the ratios 1·25 and six under the ratio 0·67.

At 450 deg. Cent. six pure torsion tests were made, six tests under the ratios of

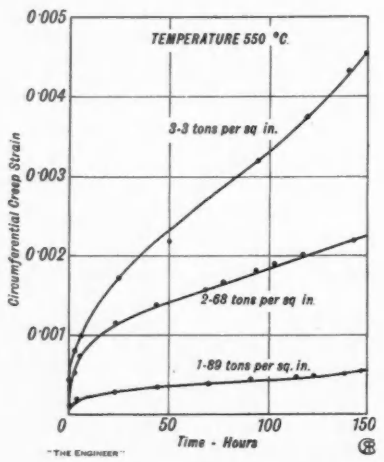


FIG. 9—*Creep Strain-Time Curves for Pure Torsion Tests*

torsion to tension stress 2·48 and 1·26, four under the ratio 0·65, one under the ratio 0·33 and one under the ratio 0·23.

At 550 deg. Cent. five pure torsion tests were made, four tests under the ratio of torsion to tension stress 2·5, five tests under the ratios 1·25 and 0·67 and two tests under the ratio 0·33.

(7) *Results of Experimental Work.*—Curves of the axial and circumferential creep strains (excluding the initial plastic strain, which is covered by the stress-strain relations given in paper[13]), plotted against time over a testing period of 150 hours for each test, were found in all cases to have the same geometric form for any individual temperature. To determine this common form as precisely as possible, a comparison of the curves was made by plotting all the results in one diagram as in Fig. 5, which shows the composite curve for all strain time curves at 350 deg. Cent.

Since the creep readings in the torsion tests were less affected by temperature variations than those in other tests, the mean form of the curves for the pure torsion tests was first ascertained and plotted to a scale equivalent to that of a test at one of the highest torsion stresses. The creep readings for each of the other tests were plotted to modified scales of suitable magnitude to make the enhanced readings of each individual test fit the mean curve as closely as possible. The mean curve form for all the tests was then drawn through the points as shown in Fig. 5.

All the curves for the individual tests were drawn by appropriate reduction of scale and were therefore geometrically similar. Errors in tests giving smaller strains are considerably magnified in Fig. 5.

Examples of the curves for individual tests are shown in Figs. 6–9 for the three temperatures concerned. It will be seen that the experimental points are well fitted by the mean curve forms.

At 350 deg. Cent. the composite curve form is such that the creep rate varies with time as follows :—

Period of test, hours	150	100	50	25	10
Ratio of rate of creep to that at 150 hours	1	1·1	2·1	3·4	7·9

At 450 deg. Cent. the composite curve form is such that the creep rate varies with time as follows :—

Period of test, hours	150	100	50	25	10
Ratio of rate of creep to that at 150 hours	1	1·7	2·55	3·75	7·0

At 550 deg. Cent. the composite curve form is such that the creep rate varies with time as follows :—

Period of test, hours	100	50	25	10
Ratio of rate of creep to that at 100 hours	1	1·43	2·05	3·9

(To be continued)

Nomenclature

Applied tensile stress	p
Applied torsion stress	q
Major principal stress	σ_1
Minor principal stress	σ_2
Secondary principal stress	$\sigma_3=0$ in all tests
Axial creep rate	C_a
Circumferential creep rate	C_c
Creep rate in direction of major principal stress	C_1
Creep rate in direction of minor principal stress	C_2
Creep rate in direction of secondary principal stress	C_3
Time	t
Angle between direction of major principal stress and axis of specimen	ϕ
Ratio q/p	a
Quantity $\sqrt{1+4a^2}$	b
Octahedral shear stress	σ_0
Octahedral shear creep rate	C_0
Principal strains	ε_1, ε_2, ε_3

Continental Engineering News

Railway Reconstruction Plan in Spain

A plan for the reconstruction of the Spanish railways is estimated to cost 6000 million pesetas (£135 million). About 700 miles of line will be electrified at a cost of some 1000 million pesetas and sums of similar magnitude will be expended on the permanent way and in rolling stock. Some 100 new locomotives are to be constructed and a considerable sum will be spent on the construction of diesel railcars and the restoration of existing locomotives. The plan involves a fairly comprehensive reconstruction of railway facilities; it has been approved by the managing board of the Spanish railways and work has now commenced.

Reconstruction of the Donetz Basin, U.S.S.R.

Interesting details of reconstruction work in the Donetz Basin are given in the Soviet periodical *Planovoe Khosaistwo* (Planned Economy). In 1940 this area produced some 85,000,000 tons of coal. During the second world war the Germans destroyed not only the mining industry but also all the iron and steel plants in the area. Sixty-two blast furnaces, 213 open-hearth furnaces, 248 rolling mills and numerous other plants were blown up. Also the enemy destroyed all power stations as well as the railway network.

Owing to the major importance of the Donetz Basin to Soviet economy, reconstruction work started as early as September, 1943. Between September, 1943, and June, 1945, 162 pit-head steel frames and 240 coal extraction machines were erected; and 253 main fans and 100 compressors were put into service, as well as 380 miles of mining works. By the end of 1948 300 pit-head frames, 600 fans, and 300 compressors as well as 800 miles of mining galleries and numerous colliery buildings had been restored. The mechanisation of the coal mining industry has also been further developed. The Soviet five-year plan contains provision for the reconstruction of seventeen steel plants and seven tube mills in the Donetz Basin. It is hoped that by the end of the first post-war five-year plan, the output of iron and steel, coke, pig iron and rolled steel products in this area will reach the pre-war figure.

Electrical Energy in the Belgian Congo

According to the Belgian review *Industrie*, two important hydro-electric plants are now being built in the Belgian Congo (Katanga) by the Union Minière. These plants are the Koni and the Nzilo stations. The Koni scheme includes a dam in the Lufira valley, which will retain 26,000,000 cubic yards of water. The head of 193ft is utilised by a power station equipped with three turbines of 20,100 h.p. The Nzilo scheme includes the construction of a dam 230ft high on the Luabala, which will retain 2,100,000,000 cubic yards of water. The maximum head to be utilised will be 272ft, and the power house will be equipped with three Francis turbines of 38,000 h.p. capacity. Later a fourth turbine of the same type and capacity will be added.

At present the main hydro-electric plants in the Belgian Congo are at Mwadingusha and Sanga. The Mwadingusha plant, which utilises the energy of the Cornet waterfall, is equipped with five generating groups, having an overall capacity of 55,000kW. In 1947 the output was 442,000,000kWh. This station supplies current to the cities of Elisabethville, Jadotville and Kolwezi. The Sanga plant has a capacity of 7500kW which is shortly to be increased to 10,500kW. It utilises a 69ft fall on the Inkisi River, a tributary of the River Congo. This station supplies Leopoldville with electric current by means of a 70-kV transmission line, 50 miles long. In 1947 the output of the Sanga plant amounted to 28,000,000kWh. In addition to these plants there are many power stations owned by industrial companies. Several projects for new hydro-electric plants are at present being investigated, including the areas of Stanleyville and Albertville, the Kivu, and Ruanda in the Lower Congo.

A Compensated Boiler Feed Pump

DURING a recent visit to the B.E.P. works of the Harland Engineering Company, Ltd., Alloa, we inspected on the test bed a new design of boiler feed pump (see Fig. 1), which has been developed by the firm, to give reliable service under standard and emergency conditions of power station operation. Going through the shops, we noted parts of nearly thirty such pumps now under construction.

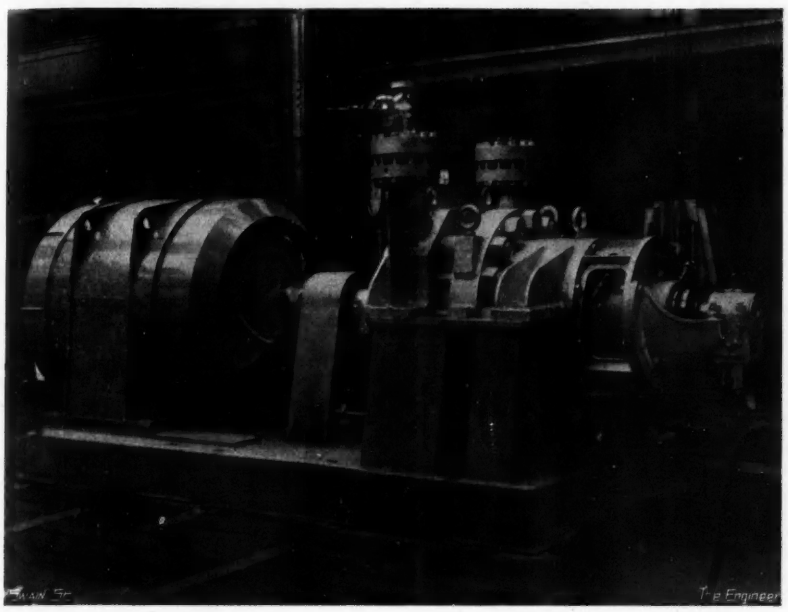


FIG. 1—PROTOTYPE PUMP ON TEST BED

Boiler Feeding Problems

Before describing the new Harland compensated pump, it is of interest to review briefly the present trends in power station boiler feeding methods, which led the company to seek to design a pumping unit which would meet the present and future demands. Modern boiler practice requires a feed supply of high temperature water at the regulator inlet, whatever may be the designed system figure at the pump inlet. Present and recent normal practice has been to feed the water to the pump at or near atmospheric boiling point, 212 deg. Fah. After leaving the pump it is usual to heat the water by bled steam to a temperature of 300 to 450 deg. Fah., after which it passes through the economiser to the boiler.

As power station steam pressures have progressively increased, it has been necessary to impose correspondingly greater pressures on the high temperature heaters. During the 1930s it was attempted in certain power stations to place the feed water heaters before the boiler feed pump so that the duty of the heaters became less onerous in respect of pressure, whilst the hazard due to the temperature change of the liquid feed, passing through the boiler feed pump, increased. This increase of feed water temperature at the boiler feed pump was by no means universal, as in some power stations it gave rise to operating difficulties with the pumps. As a result there was a tendency in these particular stations to revert to the practice of feeding the boilers with water having a temperature range at the pump of 170 to 250 deg. Fah. Whilst this proved satisfactory for boilers working at 600 lb per square inch turbine stop valve pressure the recent increase to 900 lb per square inch and on some larger units to 1500 lb per square inch has imposed greater pressures on the feed water heaters. The problems thus encountered led to a reconsideration of the lay-out of the feed system, which has resulted in the demand for a boiler feed pump capable of handling feed at temperatures up to 450 deg. Fah., thereby permitting the heaters to be installed on the low pressure side of the feed pump.

Other difficulties met with in boiler feeding arose from temperature fluctuation, particularly in multi-stage pumps in which several chambers were held together by long through-bolts. While satisfactory operation was obtained at the top temperature, when sudden cooling occurred, the differential contraction of the various parts of the pump was liable to cause joint fracture. Again, the design of glands needed careful attention, as in order to handle water at high temperature an inlet temperature slightly greater than saturation must be maintained in order to avoid flashing into steam. The leak-in principle was tried but this needed the injection of de-aerated water, and often a separate sealing pump.

Other factors causing difficulty were the lack of symmetry of end covers which gave rise to local distortion, particularly under transient temperature conditions. Light shafts which permitted whipping gave rise to excessive wear and the opening of rotating joints, while malalignment was brought about by the weight of pipes supported on the pump or pipes strained to branches, which often weakened early barrel designs. Differential expansion under temperature variation conditions presented further difficulties, and suspension enabling expansion to take place freely under temperature change conditions was found necessary. Good gland cooling was indicated and problems of thrust and careful design of balance discs, impellers and passages were shown to be necessary if freedom from cavitation attack and the creation of an unduly high

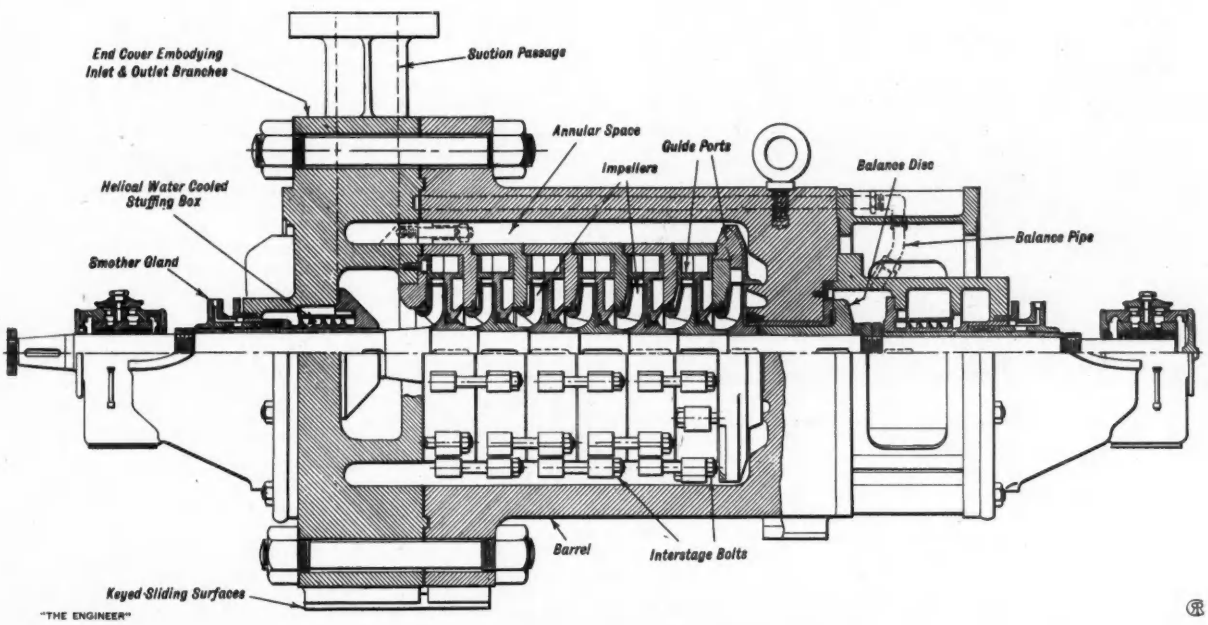


FIG. 2—LONGITUDINAL SECTION THROUGH PUMP

level of de-aerator or heater pressure before the feed pump were to be avoided. All these factors were taken into consideration before the design of the new pump was started.

The New Harland Engineering Design

The design work was preceded by carefully planned research work. As will be seen from the accompanying drawing, the pump employs the expedient of containing the multi-stage pump assembly within an entirely novel form of barrel casing, thereby forming a free annular space between the two parts, into which the full discharge is directed from the final stage. The pressure within the free space thus serves to maintain the inner pump assembly under compression, thereby keeping the joints of the various stages under maximum compression, suppported by light stage-to-stage tie bolts, which it is claimed are substantially invulnerable to temperature changes. The bolts are designed to carry the initial surge of pressure within the pump previous to the time that the water reaches and counteracts that pressure in the surrounding annulus. The arrangement of these stage-to-stage tie bolts is clearly shown in the accompanying sectional drawing, Fig. 2. The principle of encasing the pump assembly with its own pressure water ensures that any change in the temperature of the feed water is transmitted almost instantaneously to the entire pump assembly both internally and externally, thereby eliminating the expansion and contraction stresses caused by temperature variations in the adjacent components. Further, the inner pump assembly, which is constructed as an integral unit, has freedom to expand or to contract within the barrel casing. The pressure joint is unaffected by this movement and the pump efficiency is unimpaired. It will be seen that there is only one external pressure joint between the single end cover and the pressure barrel, which, as shown in Fig. 4, is secured by short bolts of adequate strength. The entire unit, it will be seen, is supported from the outer pressure barrel and the end cover on the centre line of the shaft, thereby ensuring true alignment with the driving unit at all pumping temperatures.

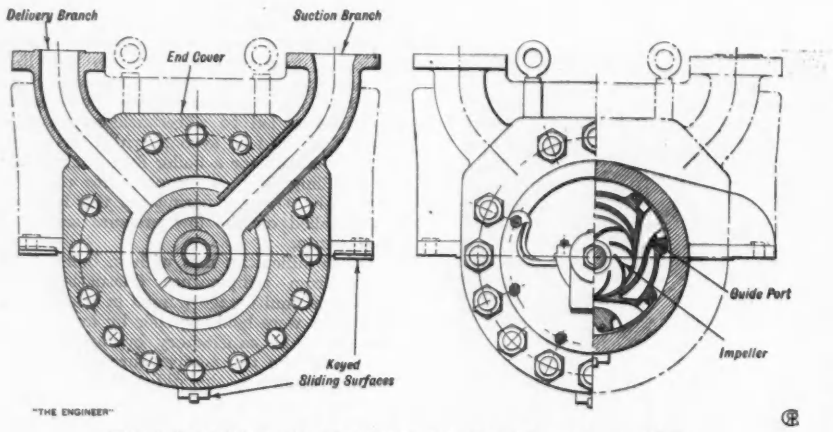


FIG. 3—SECTION THROUGH COVER, IMPELLER AND GUIDE PORT

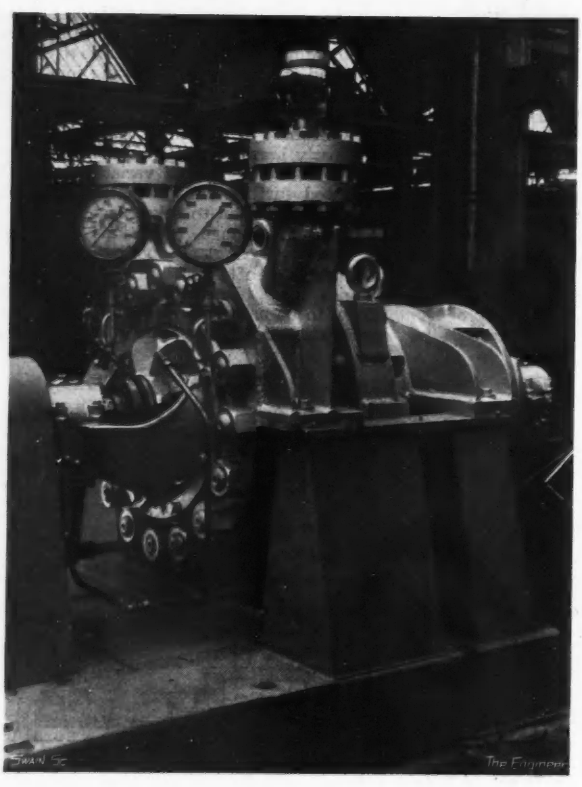


FIG. 4—PROTOTYPE PUMP FROM DRIVING END

In order to obtain maximum strength it was decided to make all parts where possible from steel slab. The end cover is made from a solid steel slab, 12in to 13in in thickness, while the barrel is formed from a steel forging of symmetric section. The diameter of the shaft was increased to give approximately twice the rigidity normally used in boiler feed pump practice. It may be noted that the shaft is stepped so that the thrust of each impeller is taken individually by a shoulder on the shaft instead of being transmitted along the whole length of the impeller and sleeves. The shaft, the impellers and the balance disc are all constructed in stainless steel.

The impellers, shrouds, guide-ports, chambers, balance discs, and sleeves, all embody the heavy sections and are marked by simplicity in their design. Dynamic balancing is employed, not only for the individual impellers but for the whole assembled rotating unit. A further design point is the arrangement of the delivery and suction branches on the cover and their strengthening by webs to withstand any pipe weight which accidentally might be taken by the pump. With the arrangement shown such stress is carried directly by the bed-plate. The arrangement of the branches will be noted from the section through the cover reproduced in Fig. 3, while the stiff webbing of the branches is clearly shown in Fig. 4, which is a view of the pump taken from the driving end. This view also serves to illustrate the way in which the auxiliary joints for balance pipes and pressure gauge tappings are bolted to flange facings machined on the face of the solid cover.

The pump stages are, as will be seen from our illustrations, made as a complete inner assembly, which has freedom to slide within the steel barrel casing. The sliding surface of the inner pump is made of the smallest diameter possible, so that any differential expansion causes a minimum change of radial alignment. Adequate clearance is allowed in an axial direction between the impeller and the stages, which is designed to permit the largest possible movement likely to occur in practice.

Attention may be drawn to the transverse and longitudinal keys shown in Figs. 2 and 3, which are so disposed as to ensure that however the pump temperature may differ from that of the bed, exact alignment with the driving unit is maintained, under all temperature conditions.

Great care was exercised to provide for uniform rates of heating throughout the pump.

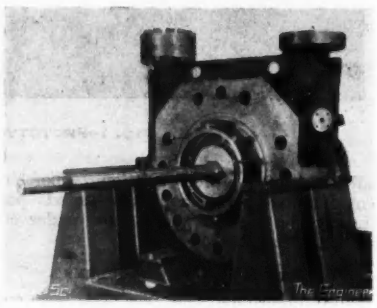


FIG. 5—COVER WITH ONE STAGE ASSEMBLED

The water, as Fig. 3 shows, enters the suction branch and passes to the centre of the inner pump, from which point it passes through the pump and is delivered to the annulus surrounding the inner pump, from which it passes through the main cover to the delivery branch. It is claimed that the positive circulation inside the whole area of the inner pump completely avoids the formation of hot or cold patches during transient temperature conditions. When the temperature of the feed supply is raised or lowered the incoming water passes through the pump with a uniform front, which forms a plane at right angles to the shaft. All expansion takes place therefore uniformly round the circle of the barrel and in a longitudinal direction, there being no tendency to bend the pump. The provisions for longitudinal alignment have already been referred to. At all points where contact is made between stationary and sliding parts the masses involved have been carefully equated for similar rates of heating under transient temperature conditions.

The design adopted is also convenient for assembly and dismantling, as Figs. 5 and 6, showing one stage assembled and the complete assembly of the inner pump, clearly indicate. The prototype unit, shown in Figs. 1 and 4, was completely dismantled in four hours. After the removal of the free end bearing bracket and the balance disc cover, &c., the barrel can be removed and the stages of the inner pump can be stripped in situ or the whole inner pump taken to the workshop. As shown by the engravings, rebuilding is effected in the same way by erecting stage by stage and

checking alignment and rotation whilst building is in progress.

Servicing is facilitated by the fact that all joints may be made without additional machining and by the useful arrangement of the delivery and suction branches, which permits the pump to be overhauled and if necessary stripped, without having to break the branch connections.

For cooling the stuffing boxes only raw water is used. As Fig. 7 shows, the water is led to a shell surrounding the packing, which gives the greatest cooling effect at that point. It then progresses in the form of a helix towards the pump itself, increasing in temperature as it proceeds along the helix, and is afterwards led to waste. The helix surrounds the bush, the bore of which has a normal clearance on the sleeves. The temperature difference between the high temperature water leaking along the clearance and the cooling water is constant at all points. Besides avoiding distortion and hot spots, the gland cooling arrangement described has the additional advantage that the cooling of the leakage water is sufficient to enable the packing to withstand the pressure without disintegration. A smother gland, shown in the drawing, Fig. 2, provides a trickle of cold water to smother any steam, and it assists in preventing the heat being conducted along the shaft, thereby keeping the bearings cool.

Before describing the prototype pump and its tests it may be mentioned that the drawing reproduced in Fig. 2 is that of a seven-stage compensated feed pump, designed for a duty of about 420,000 lb per hour delivered at 2000 lb per square inch, the feed being supplied at a pressure of about 800 lb per square inch.

The Prototype Pump

With the object of putting the design theory to a practical test, it was decided to build a prototype pump and to subject it to a variety of tests. In the early stages we understand, difficulty was experienced in obtaining a suitable packing and stuffing box for operation at an inlet pressure of 800 lb per square inch and a delivery pressure of 1400 lb per square inch, with a working temperature of 500 deg. Fah. On one occasion a sudden failure of inlet pressure occurred when the test alternator driving the booster fell out of step. The feed pump then ran steam logged for a few minutes at temperatures from 490 to 505 deg. Fah. In

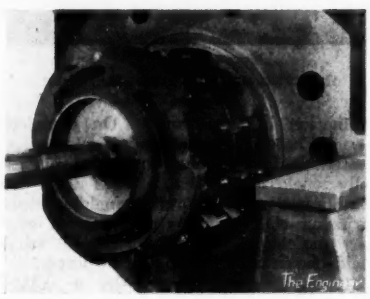


Fig. 6—Completed Inner Assembly

spite of this drastic treatment no seizing took place and the pump suffered no distress. It is of course, emphasised that although the pump showed a great margin of safety in this respect, the running under steam logged conditions without seizure cannot under any circumstances be guaranteed. The incident does show, it is claimed, how the contact surfaces of the internal supports have been reduced to give a greater margin of safety in the case of accidental steam logged operation.

During these early tests, too, it was found that on a sudden temperature reduction from 500 deg. Fah., a slight weep occurred at the main joint, which afterwards soon made up. A modification was made to the joint which overcame that difficulty. The final form of joint has been repeatedly tested and despite the most violent temperature fluctuation, there has been on no occasion the slightest indication of the previous defect. In the course of these prolonged tests other minor faults developed, but they were regarded as normal teething troubles arising from the novel practice embodied in the pump design, and each of these faults has been finally eradicated.

The frame chosen for the prototype pump was a type CRC unit with four stages designed for a duty of 420,000 lb per hour, at a discharge pressure of 1280 lb per square inch and an operating water temperature of 500 deg. Fah. At a specific gravity of 0·78, this corresponds to 920 gallons per minute. The generated

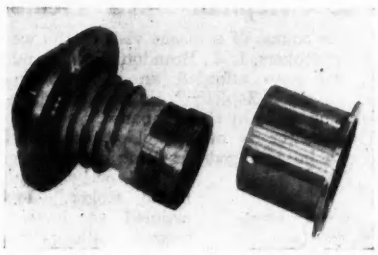


Fig. 7—Water-Cooled Stuffing Box and Sleeve

pressure in the high temperature runs was 780 lb per square inch with cold water and 610 lb per square inch with the water at a temperature of 500 deg. Fah. In order to avoid steam logging, a suction pressure of 725 lb per square inch was furnished by two Harland multi-stage booster pumps, running in series, thereby making a total discharge pressure of 1335 lb per square inch at the full temperature and 1500 lb per square inch when cold. These temperatures were measured at the feed pump discharge branch.

Some Test Results

Two demonstration tests of the unit we have described and illustrated were carried out on the test bed of the Alloa works of the Harland Engineering Company, Ltd., before groups of consulting engineers and representatives of the British Electricity Authorities. These tests were undertaken to show that the new pump was capable of withstanding violent fluctuation in temperature without causing mechanical distress or leakage at the one high pressure joint or elsewhere on the pump.

The pump was driven, (see Fig. 1), by an available Harland 750 b.h.p. test bed motor of the totally enclosed frame cooled type, at a speed of 2980 r.p.m. This motor was, we understand, somewhat larger than that which would have normally been needed for the pump. Previous to these demonstration tests other tests had been successfully carried out and had shown that the head, volume and efficiency characteristics of the pump were in strict conformity with the specification to which it was designed. It was, of course, not possible within the limits of test bed practice to reproduce exactly the conditions under which the pump would normally operate, but the arrangement was such that the Harland engineers were able to subject the feed pump to treatment which might reasonably be expected to show up any deficiencies. The actual trial runs did, however, it is considered, reproduce conditions far more severe than those generally to be expected when a failure in the feed system is responsible for sudden changes taking place in the feed water temperature. As it was not possible to provide feed water at a sufficiently high temperature, the motor h.p. was utilised and converted into heat within the pump. With a closed delivery valve the temperature rose at an initial rate of about 15 deg. Fah. per minute. Care had to be taken to maintain a saturation pressure of 665 lb per square inch gauge whilst running at 500 deg. Fah. as in the neighbourhood of this temperature saturation pressure rises quickly. To the 665 lb pressure, pressure margins were added, to cover possible pressure drop between the suction branch of the pump and the impeller eye, and temperature fluctuations. Means were provided for introducing small quantities of cold water to control the temperature within the pump during the running of the tests.

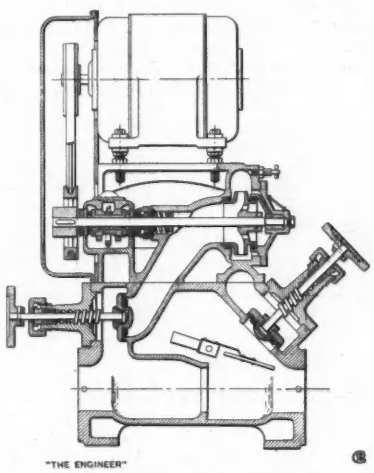
During both demonstration runs the prototype pump unit was operated for one hour at the full temperature of 500 deg. Fah., so as to stabilise the temperature in the various parts of the pump. At the end of this time a sudden flow of cold water was introduced into the pump in order to effect rapid cooling and so disclose any leakage or distortion which such severe conditions might provoke. The opening of the valve actually caused an initial temperature drop of 280 deg. Fah. per minute on the first test and 300 deg. Fah. on the second test, but despite this violent change in feed temperature there were no indications of failure or loss of efficiency, either in the main joint or in other parts of the pump. After running for a further hour, the pump was completely dismantled so that all the components could be inspected by the groups of engineers who witnessed the tests. It was found, however, that the harsh treatment had not caused any damage whatever to the glands, sleeves, joints or bearings, nor to any parts which might have proved vulnerable to strain from temperature variation.

Although the present article is the first of its kind to give full descriptive details of the new design of feed pump we have dealt with, we understand that full specifications and drawings of the pump have for some time been in the hands of consulting engineers and power station authorities, and it may be considered to be some measure of the practicability of the new design that, as already mentioned, nearly thirty units have been ordered for power stations and industrial plants.

A Small Circulating Pump

The range of centrifugal pumps made by Holden and Brooke, Ltd., of Sirius Works, Manchester, has been extended by the recent introduction of a new circulator for low pressure hot water heating and domestic systems. The arrangement of the new circulator, known as the "Super Selfix Mark V," can be seen in the drawing reproduced below.

An electric motor is mounted on top of the pump and drives the impeller shaft through



Section Through Circulator

vee-belts which, together with the pulleys, are protected by a guard of plastic material. The shaft is carried in two long bush bearings; the internal bush at the impeller end being lubricated by the pumping medium. The external bush at the drive end is made of oil-retaining bronze and has wick feed lubrication. A rotary sealing device is interposed on the impeller shaft to prevent leakage from the interior of the pump casing.

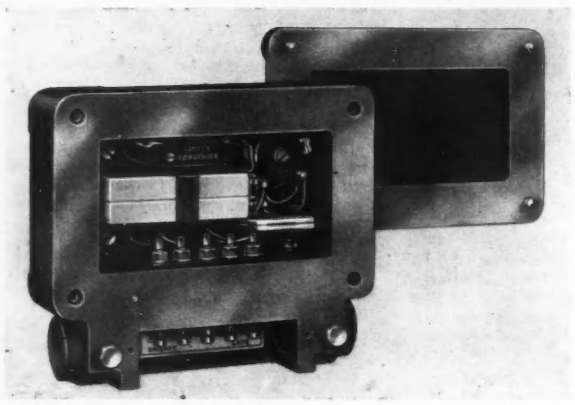
The pump casing, cover and pipe bed are of cast iron and the impeller, which is of gunmetal, is machined to close limits to give hydrau-

lic balance and avoid end-thrust. Screw-down suction and delivery valves fitted to the pump are primarily intended for isolation but can, if required, be used to control its capacity. An automatic self-seating non-return valve is designed to swing to the open position when the pump is shut off to provide a full bore flow for gravity circulation. This valve, which is of light construction, with a "Linatex" facing, is so balanced that a slight difference in pressure, depending upon the direction of flow, closes or opens the valve as desired.

This new circulator is made in two sizes on 3in, 4in, 5in and 6in pipe beds to cover a wide range of working heads and capacities.

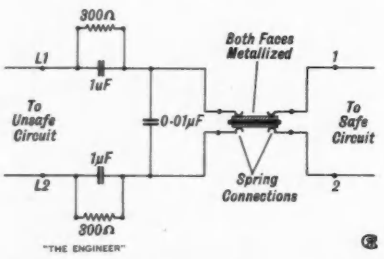
Mine Telephone Coupling Unit

Some form of mine telephone coupling unit is essential for preserving the intrinsic safety of a mine telephone circuit when connected to another circuit which is not intrinsically safe. The A.T.M. mine telephone coupling unit, designed and manufactured by the Automatic Telephone and Electric Company, Ltd., Liverpool, 7, is illustrated herewith. It is designed to permit through speech and ringing, and it uses the coventional series impedance network, but is shunted on the in-bye or "safety" side by an "Atmite" disc, as indicated in the diagram.



COUPLING UNIT WITH COVER REMOVED

The function of the "Atmite" disc is to limit the voltage across the in-bye connections to the "safe" circuit in the event of a dangerous potential being applied to the "unsafe" side. "Atmite" is a mixture of silicon-carbide-molybdenum with a ceramic binder, pressed and fired to produce a material with a non-linear resistance characteristic. Generally this characteristic is such that the effect of doubling the applied voltage is to reduce the resistance of the disc to one-sixteenth of its previous value. Accordingly, any increase in the voltage applied to the disc through the impedance network causes the resistance of the disc to fall and thereby limits the voltage applied to the "safe" circuit.



CIRCUIT DIAGRAM FOR COUPLING UNIT

It will be seen from the diagram that the connections to the disc are made by springs bearing on the metallised surfaces. Any disconnection in the wiring of the coupling has the effect of disconnecting the circuit to the "safe" side, which is therefore protected against any dangerous over-voltage.

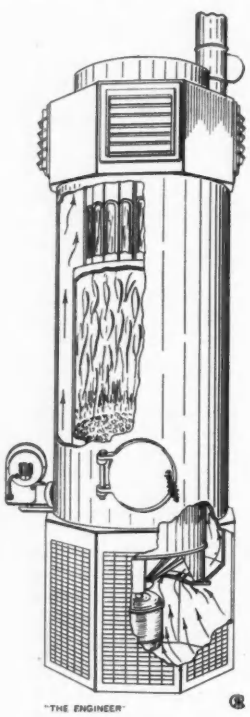
Physically, the "Atmite" disc is sandwiched between the two halves of a porcelain holder, which is mounted in the lower right hand corner of the coupling unit as shown in the photograph reproduced herewith. The components of the coupling unit are housed in a robust, heavily flanged case which measures 7½in by 6½in by 3in, and is certified by the Mines Department as intrinsically safe.

The "Zephair" Air Heater

In the course of a recent visit to the works of Prior Stokers, Ltd., Brandon Road, London, N.7, we were afforded an opportunity to examine the "Zephair" air heater, which is now being made by the company.

This heater is of all-welded construction and can be arranged for firing either by gas, oil fuel, or by an automatic stoker. It is claimed to have an overall efficiency of some 85 per cent and an output of 500,000 B.Th.U. per hour.

The arrangement of the heater can be seen in the sketch we reproduce below. It is some 3ft diameter by 10ft high. Air is drawn in through fixed louvres in the sides of the hexagonal base and blown upwards by a motor-driven forced-draught fan. This air is first warmed as it passes through an annular space formed between the outer wall and the combustion chamber. At the top of the combustion chamber is a nest of tubes, through which the combustion gases pass on their way to the flue. Air flowing up the annular space is directed by means of baffles round these tubes to remove a large proportion of the heat remaining in the gases. The heated air finally passes into a hexagonal compartment at the top and then out through adjustable louvres. These adjustable louvres can be built into any or all sides of the upper compartment, their number and setting being arranged according to the arrangement of the area to be heated.



AIR HEATER

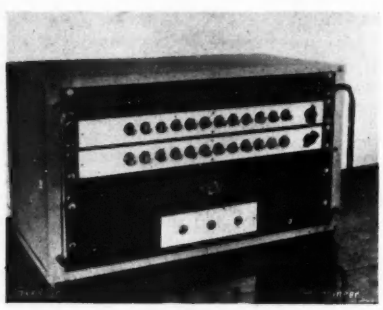
The combustion chamber is completely isolated from the outside jacket of the heater and the cold air passing up the annular space maintains it at a low temperature. For maintenance and inspection purposes a convenient door gives access to the combustion chamber and the fan and motor assembly can be easily removed from the base chamber. When necessary the top chamber can be removed and the nest of tubes lifted out of the combustion chamber for servicing.

In hot weather the apparatus can be used, without firing the combustion chamber, to assist the circulation of air in a room, by drawing cool air from a low level and blowing it out over a higher level in a room.

An Electronic Counter-Batcher

An accompanying illustration shows a recent development of Sargrove Electronics, Ltd., an electronic batcher for counting and batching small articles at high speed. The maximum counting speed of which this apparatus is capable—said to be 20,000 per second—can be fully utilised only in certain scientific applications, but the apparatus is primarily designed to be of industrial use.

Known as the E. C. B. 144 equipment, the apparatus is designed as standard to count maximum batches of one gross at a maximum speed of ten per second. The quantities counted and batched are predetermined by the setting of two switches. Visual indication is given of units, tens, dozens and grosses, or any other combination in that range. On completion of each batch the cycle is automatically repeated. Briefly the instrument is a miniature totally enclosed ventilated rack and panel assembly in a metal case, the principle of operation being ring circuits (not binary), giving direct indication and employing a reliable coincidence circuit for batching purposes.



ELECTRONIC COUNTER-BATCHER

Batching can be effected by an electro-mechanically-operated trap or gate, designed specially for the articles to be batched, which diverts the stream of articles from the full container to the one that is empty and waiting. At the same time a record of batches completed can be obtained on an electro-magnetic counter, which can, if required, be placed in a position remote from the main apparatus.

The mains input to the machine may be from 200 to 250V a.c. The standard form of input to the counter is from a photo-electric detector head unit, which may be mounted on the machine or conveyor producing the articles, but special input circuits can, of course, be built to suit individual requirements. Where the packing or batching rate exceeds the output of one machine, multi-channel input circuits can be provided, which will indicate an additive total. The largest batch for which the standard counter can be used, as stated above, is one gross, but the addition of a further stage enables the instrument to indicate batches up to twelve gross.

American Engineering News

Proposed Brooklyn-Staten Island Bridge

Military approval has been given to the proposed suspension bridge over the Narrows between Staten Island and Brooklyn, a scheme which, among other advantages, would provide motorists travelling between New England and the West and South with a by-pass round the congested metropolitan areas. Preliminary details for the construction of the bridge across the channel, between the Fort Hamilton area in Brooklyn and the Fort Wadsworth section of Staten Island, have been worked out by the Triborough Bridge and Tunnel Authority. Arrangements for a bond issue to finance the work must await completion of the authority's present major project, the Battery Tunnel to Brooklyn, which is to be finished next year. Then a further three years will be required to build the bridge. In anticipation of the bridge's construction, planning and some actual work has already started on the network of parkways which will be needed to connect the bridge with the city's traffic system.

On Long Island, work is now well under way on a series of express roads which will connect existing parkways, and will eventually provide a through highway extending south from the Bronx-Whitestone Bridge to Fort Hamilton. It is estimated that this road system, the major link of which will be the new Brooklyn-Queens Expressway, will be open to traffic within the next two years. In the meantime, work has begun on plans for the proposed Richmond Parkway on Staten Island, which will provide a direct route from the northern part of the island to the Outerbridge Crossing, which leads to Perth Amboy and on to the Jersey shore. An alternative route across Staten Island from the Narrows would be westward along the projected Clove Lakes Expressway, which is to connect with the Goethals Bridge and the Elizabeth section beyond.

Preliminary plans indicate that the Narrows Bridge will have a total length of 6540ft, with a 4620ft span between the two supporting towers. The bridge will rise 237ft above the high water level, thus allowing ample clearance for such ships as the "Queen Mary," a factor which had to be taken into account in planning this project. It is intended to carry six lanes of traffic,

Kentucky Flood Protection Scheme

One of the largest city flood protection schemes ever undertaken is now well under way at Louisville, Kentucky. Designed to avoid repetition of the disastrous floods of 1937, when the Ohio River inundated two-thirds of the city, the scheme is being carried out under the supervision of the Louisville District Corp of Engineers and is scheduled for completion in 1953. The work calls for over thirteen miles of new earth levees, which will require some 3,000,000 cubic yards of compacted fill and just over four miles of reinforced concrete wall, calling for 60,000 cubic yards of concrete. To give passage through the new levees and concrete retaining walls, fifty gates, the highest of which will be 20ft, will be provided. These gates will be of lightweight sectional design for the purposes of speedy manual operation during flood conditions. In addition to these gates there will be thirty ramps, which will pass over the wall 3ft below the top, the intention being to build up the remaining 3ft, when the river height reaches dangerous proportions, by sandbagging. To cope with flood waters which may encroach within the city, fourteen pumping stations, having a total combined pumping capacity of nearly 6½ million gallons per minute, are also being provided.

New Ocean Canal

The development of oil prospecting in the isthmus of Tehuantepec and a recent international meeting of civil engineers at Mexico City is reported to have revived serious consideration of a canal across the narrowest part of Mexico to connect the Atlantic and Pacific Oceans. The route most favoured would extend from Coatzacoalcos on the Gulf of Mexico to a point near Salina Cruz on the Pacific side, a distance of only 140 miles. Although the distance between the first-named place and New York is approximately the same as to the Panama Canal, namely, 2040 miles, a considerable saving would be effected on the Pacific side of the canal for journeys to San Francisco. In fact, any voyages from the eastern seaboard of the U.S.A. to the west coast would be 1500 miles shorter than by the present route through the Panama Canal. To Asiatic ports it is estimated that up to 2000 miles would be saved. An advantage of the scheme is that the canal could use a considerable part of the Coatzacoalcos River's bed over a distance of some ninety miles, although, of course, a number of cuts would have to be made to straighten some of the bends in the river. With a width varying from 400ft to 600ft and a maximum depth of 60ft, it is estimated the canal could be built in approximately three years at a cost of 3,500 million dollars.

Cairo Bridge Strengthening

The Illinois Central Railroad bridge over the Ohio River at Cairo, Illinois, is to have a further strengthening programme carried out on it at a cost of some 6,000,000 dollars. Claimed to be the longest all-steel river crossing in the world when originally opened in October, 1889, the bridge has a total length of 7683ft. It was first strengthened to meet the demands of heavier rolling stock in 1914. Now a total of 3383ft of bridge is to be replaced, involving the use of some 10,000 tons of steelwork. Although the existing piers are being used to support the new spans, repairs are having to be carried out on three of them as the work proceeds. Additionally, new piers are being placed midway between three of the existing spans to enable three 400ft through truss spans to be replaced with six 200ft deck spans. It is expected the work will take three years to complete.

Model Tests for Dredging Equipment

The experimental towing tank maintained by the Stevens Institute of Technology at Castle Point, Hoboken, New Jersey, is being used to carry out model tests of an improved type of hydraulic pipeline dredger intended for use by the U.S. Army Corps of Engineers in channel maintenance work on the Mississippi River. The dredger will be of all-welded construction with hull dimensions of 256ft length, 53ft beam, and approximately 10ft depth, and will be self-propelled by three 7½ft diameter screws driven by reversing steam turbines of 1200 h.p. each. The dredger pump will have a 36in diameter discharge and will be driven by a steam turbine of 4000 h.p. Accommodation will be provided for ninety-nine officers and men. The tests will determine the resistance and propulsive characteristics of the hull when the vessel is operating individually at speeds from 6 miles to 12 miles an hour and when operating with its attendant fleet at speeds from 6 miles to 10 miles an hour. The normal attendant fleet consists of a 120ft by 30ft fuel oil supply barge and seventeen 48ft pipe-line pontoons used to discharge the material from the dredger to a selected place outside the river channel. Tests will be conducted under the various arrangements of the dredger and attendant plant at simulated water depth and current conditions as are usually encountered in actual dredging operations. Similar tests are being carried out in the same tank for a 250-ton diesel electric, twin-screw hopper dredger, to be used by the Oil Companies group on Lake Maracaibo. The dredger, which was designed by the marine department of the Standard Oil Company, New Jersey, acting on behalf of the Creole Petroleum Corporation, will be built by Canadian Vickers, Ltd., of Montreal, and will have 3165 tons displacement at its designed fully-loaded draught of 15ft. Tests will first be made to determine the resistance of form in the strip-down condition and then will be repeated while the model is equipped with a full set of appendages. These appendages will include bilge keels, screw bossings, rudders, hopper door openings and suction drag-pipe outboard assemblies. The purpose of the tests on the strip-down hull model is to verify the designer's estimate of hull-form performance and to ascertain approximately the flow lines so as to arrange bilge keels and screw bossings in the most efficient place. Flow lines are found by running dye into the water through holes in the hull surface. The dye clings to the hull surface, marking the stream lines of the water, and thus indicating the most efficient positions for appendages.

Largest Dam in Eastern States

At Mount Morris, in the western section of New York State, work has recently begun on the southern half of the Genesee River dam. The dam was started in April, 1948, and is estimated to take another two years for completion. It will be just over 1000ft long dan 246ft high, the cost of the work being over 20,000,000 dollars. An unusual feature of the scheme is the provision of special facilities for sightseers to view the work in progress, taking the form of special approach roads and the setting aside of parking space for approximately 150 cars at a point above the north bank of the Genesee and overlooking the site. Works of this magnitude are, of course, a rarity in the eastern section of the U.S.A., although fairly commonplace out West. The purpose of the dam, which is being built under the supervision of the Army Corps of Engineers, is flood control, the intention being to impound some 337,000 acre-feet of water to safeguard 17,000 acres of highly productive farmland on the flatlands of the valley of the Genesee.

New Lightweight Roofing Material

A single-storey warehouse covering a total area of 9 acres, which is now being built at Bloomfield, New Jersey, is to be covered with an entirely new form of roofing material. Known as "Kaylo," this material consists of tiles composed of a white cellular compound of calcium silicates, which are precast in slabs approximately 2½in thick, weighing 5 lb per square foot. Developed during the war by American Structural Products, a subsidiary of the Owens-Illinois Glass Company, this is the first commercial application of the material, which is likely to be used in increasing quantities for roofing purposes, due to its combination of low weight and high structural strength together with high insulating and fire-proof factors. It is claimed to be capable of carrying a load of 50 lb to the square foot with an ultimate safety factor of eight.

Highway Construction in New York

The New York State Department of Public Works placed during the past year a total of 156 contracts providing for 566 miles of highway construction and reconstruction at a total cost of 85 million dollars. This is an increase of 60 per cent over the work placed for the previous year. Included in the work being carried out are 184 bridges, grade crossing elimination structures, culverts and similar erections.

Continuous Rail Welding for Tunnels

The Great Northern Railway Company has recently put in hand the pressure-welding of 4 miles of continuous rail for use in their Cascade Mountains tunnel in Washington State. The work has required 800 tons of new rail, weighing 115 lb to the yard, to replace the 110 lb rail used previously. For this task a pressure-welding machine assembles the rails into sections a quarter of a mile long, which are then moved into the tunnel eight at a time on roller equipped flat cars. The joints between the quarter-mile sections are welded together in the tunnel by hand equipment.

Steel for Bureau of Reclamation

The Office of Industry Co-operation, U.S. Department of Commerce, has made allocations of steel for the first time to the Bureau of Reclamation. The allocation totals 83,618 tons and is to cover the period May 1st to September 30th this year for twenty-six civil engineering projects of the Bureau.

Industrial and Labour Notes

Exports and Imports in June

With the publication by the Board of Trade of the trade and navigation accounts for June, details of exports and imports for that month are now available. The value of exports in June was £143·1 million, a decrease of £8·3 million compared with May, but £5·7 million more than in April. There were twenty-four working days in June, as in April, against twenty-six in May, so the daily rate of exports was 2½ per cent higher than in May and 4 per cent higher than in April. Allowing for the change in prices since 1938, the total volume of exports in June is provisionally estimated at 145 per cent of the 1938 average, compared with 153 per cent in May, and 140 per cent in April. The volume of exports as a whole in the second quarter was about 146 per cent of the 1938 average, against 156 per cent in the first quarter of 1949 and 147 per cent in the last quarter of 1948.

Compared with May most of the commodity groups of exports suffered a decline. Vehicles showed up worst by a figure £2·4 million less than the £24·8 million of May, and the number of cars and chassis exported fell by 4174 to 18,850. Exports of commercial vehicles and chassis amounted to 6333, which was 2280 less than in May, and the lowest since last August. Exports of coal at £3·8 million were the highest this year, both by quantity and value.

As has been previously announced by the President of the Board of Trade, provisional figures of exports to the United States were £3 million and to Canada £6 million.

By contrast, imports in June were a record at £201·7 million, exceeding May's figures, the previous highest, by £6·9 million. The value of raw materials imported amounted to £70·3 million, the highest since 1920. Re-exports amounted to £4·4 million and were below the average of recent months.

These figures indicate a great increase in the trade gap, which for June was the highest since September, 1947. The excess of imports over total exports was £54·2 million.

Imported Copper Rods

The Ministry of Supply announces that with effect from last Friday, July 22nd, the price for imported copper rods not less than ¼in and not more than $\frac{5}{16}$in diameter, will be increased from £113 10s. to £117 5s. per ton delivered. The statement issued draws attention to the fact that since the autumn of 1948 the premium over the current price of electrolytic copper which the Ministry pays on imported rods has been increased. As the Ministry's selling price, taking into account freight, delivery charges and other factors, is now broadly in line with world prices, the increase in the premium will be passed on to consumers.

United Kingdom Manufactures for Italy

The Anglo-Italian Joint Economic Committee held its fourth meeting from July 4th to July 15th, and the Board of Trade has now issued a statement relating to the agreements reached. Some further increases in trade in each direction above the previously agreed programme were agreed, and the payments agreement was renewed until the end of this year. The Italian Government has agreed to grant licences for United Kingdom manufacturers substantially above the level agreed in February last. Some of the more important increases are in laboratory and industrial glassware, graphite crucibles, plumbago and graphite products, scientific instruments other than electrical, electronic equipment, agricultural machinery, rolling mill equipment, plastic injection moulding machinery, aero-engine test plant, ball and roller bearings of types not produced in Italy, and industrial refrigerating plant.

In addition, the Italian Government has agreed to license certain other commodities, for which no quotas have previously been granted, including carborundum and emery for optical use, aluminium paste, and X-ray apparatus and films, and latex compounds.

Finance Corporation for Industry

The fourth annual general meeting of the Finance Corporation for Industry took place last Thursday, and Viscount Bruce of Melbourne, the chairman, made a long statement of his views. He stressed the profound repercussions of the change from seller's to buyer's market and the effects of the European Recovery Plan on the task of the Corporation. That task was to render financial assistance which could not be provided through the ordinary channels for the expansion and modernisation of existing industries and the development of new industrial activities. Difficulty had been found in satisfying that obligation, and unless there was a profound alteration of policy in this country it was his opinion that the position would deteriorate still further.

To the ordinary man and woman the platitudinous statement "we must reduce costs" had only one meaning—an attack on the wage standards for which they had so long fought and so painfully achieved. Viscount Bruce therefore thought that the first thing that had to be made clear, if full co-operation were to be obtained, was that a reduction in the weekly pay packet was not the contemplated method whereby the essential increased production and reduced costs were to be achieved The effective ways by which the results could be obtained were hard work, the maximum effort from all workers, the abandonment of out-of-date restrictive practices, the suppression of indiscipline, and the restoration of control in the trades unions to their responsible leaders

If those things could be attained, we could go forward on the basis of no increase of wages save under exceptional circumstances, possibly a readjustment of hours of work, but only after a careful examination had shown that increased economic production would result, and no general reduction of wages. If those things could not be attained, the people as a whole and the workers in particular would have to realise that an all-round reduction in wages was inevitable. It was not because anyone desired such a thing to happen, but because it would be forced on us by the hard facts of our situation.

Some fresh and clearer thinking should be done, he continued, with regard to the nationalisation of industry, and the effect it was having on our general economy. The issue should be taken out of politics. Coal was nationalised; in 1947 it made a loss of £23 million and in 1948 a profit of £1,700,000. That dramatic change was brought about by raising the price, affecting the cost of many industries, in particular, the cost of transport. We were rapidly approaching the time when the same method of raising prices would be necessary for transport. Were we to commit the incredible folly of nationalising iron and steel the same procedure would in due course be followed. Unless that trend could be reversed all hopes of economic recovery must be abandoned. He suggested with regard to coal and transport that the principle which was now accepted for national finance, that it was not necessary to balance the Budget annually, but only over a defined period of years, should be accepted and implemented. With nationalisation out of politics, efforts could be concentrated on ensuring that the boards did their job effectively and efficiently. In such an atmosphere he believed that it would be possible to attract men of ability, knowledge and experience who were at present reluctant to offer their services.

The wise handling of the problem of nationalisation would, however, only achieve the negative result of preventing costs rising. Positive action was required and to that end an essential contribution must come from efficient management, showing initiative, enterprise and vision; an all-out effort by the workers—which he was confident they would willingly make when they fully understood the seriousness of the situation—and the maximum co-operation between all parties in industry.

Viscount Bruce then stressed the need for incentive in industry by reduction of taxation, to be achieved by cuts in social service expenditure. In that connection he pointed out the lesson to be learnt from affairs in Australia in 1929, where he was faced with the same difficulties as Prime Minister of that country. Politicians were not prepared to face the issue at the time, but twelve months later the Labour Government which succeeded him was forced to make drastic cuts, including a cut of 20 per cent in social services. The position now in this country was exactly the same as in Australia in 1929.

The London Dock Strike Ended

The dockers resumed work on Monday of this week, on the understanding that resumption should be on the basis of existing national and local agreements. Troops at the end of the strike numbered 11,452, and worked 130 ships, handling 107,643 tons of goods. They were withdrawn on Saturday at noon. The strike, which was an unofficial one, has lasted about five weeks, and at one time more than 15,000 dockers stayed away from work.

Railway Wages

The railway wages dispute seems to have reached another deadlock. Last Tuesday a deputation from the National Union of Railwaymen went to see the Minister of Labour, to warn him of the effects expected to follow the recent alteration in the terms of reference for the conciliation board, which is to examine the railway wages dispute. It appears that two main objections have been raised by the N.U.R. Many delegates at a special conference protested strongly at the exclusion of railway shopmen's wages from the matters to be considered by the board. About one-fifth of the union's membership consists of railway shopmen. Secondly, complaints were made about the appointment of Sir John Forster as chairman of the conciliation board, on the grounds that he was chairman of the national wages tribunal, which recently turned down the 12s. 6d. claim.

The Minister of Labour decided to exclude employees at railway workshops from the scope of the negotiations because the Confederation of Shipbuilding and Engineering Unions, which includes many railway shopmen, refused to accept in advance the decision of the board on any points that could not be settled by negotiation. As the Minister was not willing to start discussions at a time when one union was unwilling to commit itself, he decided to limit the discussions to the grades covered by the machinery of negotiation for the Railway Staff, which does not include the railway shopmen.

Output of Coal and Coal Profits

A statement issued by the National Coal Board shows that total coal output last week was provisionally 3,657,800 tons, of which 215,500 tons was opencast. This amount was more than 500,000 tons less than for the previous week but 541,900 was lost through recognised holidays, as compared with 164,700 tons the previous week.

The N.C.B. quarterly statistical statement of costs for the first quarter of 1949 shows that 51,200,757 tons was the total saleable output and that a profit of £7,272,983 was made, equivalent to just over 2s. 10d. per ton. The account includes provision for taxation and an estimated amount of £3,300,000 payable to the Minister of Fuel and Power as interest. Although the financial results show a substantial improvement, it should not be assumed that results will necessarily be as favourable in the second and third quarters of the year, which are affected by holidays.

French Engineering News

(From our French Correspondent)

The hydro-electric scheme of Oued el Abid, in Morocco, depends on the use of the different levels of the river crossing the Atlas and the considerable difference in level between the two almost parallel valleys of Oued el Abid and Oum er Rebia. The first installations consist of a dam 120m high, which has created a lake of 4600 hectares, containing 1400 million cubic metres of water. A plant at the foot of the barrage will supply 150 million kWh annually, the installed power being 120,000 kW. A compensatory dam 3km away will retain 2,500,000 cubic metres and regulate the supply to the Afourer plant. The Ait Ouarda-Afourer tunnel will be 10·5km long and 4·5m wide, ending in forced conduits using the 230m difference in level to feed the turbines with 43 cubic metres a second. The plant will produce 350 million kWh annually, which will be carried by 150,000-V lines to Casablanca and Algeria.

In French Equatorial Africa first steps have been taken in the electrification of Brazzaville by using the Djoué falls. In the first stage, equipment will comprise two 5000-kW turbines. The head is about 20m and flow is about 55 cubic metres a second. Installations will include a tunnel between the dam and the plant and a canal linking the Congo and Djoué. When completed, Brazzaville and the whole of the surrounding area will be electrified.

* * *

Activity has been resumed in French zinc and lead mines, while a great effort is being made to reduce imports of tin by stressing national production. The Charrier mines hope to produce 200 tons in 1949, while the Nantes Ore Company expects to produce about 500 tons in 1951. The Charrier mine is the only French copper mine being worked and in 1948 delivered 320 tons of ore to industry.

* * *

According to Monsieur Jardin, Assistant Commercial Director of the Nord and Pas de Calais mines, imports of coal in the future will be mainly directed to supply the steel industry. The four largest consumers, the railways and the electricity, gas and steel industries, took 49 per cent of available coal in 1948 against only 37 per cent pre-war and also absorbed the best quality fuel. Monsieur Jardin stressed the importance of reducing these supplies so that wider contact could be made with industrial consumers. He also stated that increased production envisaged in 1952 might exceed the country's needs, particularly if there was an intensive development in the use of fuel oil. Careful watch would therefore have to be kept on imports, which might be limited to supplies for the steel industry, in order not to compromise sales of national production.

France is to use 9,600,000 dollars of Marshall Aid to buy coal and coke from Belgium, which will be delivered by the end of September. This will enable stocks to be built up throughout private industry. Imports of English coal amount to 120,000 tons monthly. For 1949 French production is expected to be 52,500,000 tons and imports 20 million tons.

* * *

The inauguration of reconstructed heavy industrial plant has just been the subject of celebrations in the North of France. Reorganisation is taking place at Anzin, Noisy-le-Sec and Escaut-et-Meuse. In order to leave the space needed at Anzin for a new rolling mill the manufacture of gas piping will be transferred to Noisy-le-Sec, where a modern welding process will be used. The Anzin plant has a steel section comprising five Martin ovens and two electric ovens producing special high-resistance steels. The speciality at Escaut-et-Meuse is the production of drawn tubes, which are produced up to 450mm in diameter. Total production will increase from 15,000 to 19,000 tons a month when a new rolling mill installation is completed at Escaut-et-Meuse, which is at present exporting about 20 per cent of its production, mainly to the Middle East.

Notes and Memoranda

Rail and Road

ROAD TRANSPORT LICENCES AND PERMITS.—Some wartime permits and other authorisations to use road passenger and goods vehicles and to act as drivers and conductors of public service vehicles are to be further extended by the Minister of Transport. The extensions are automatic, and are intended to keep the authorisations effective until they can be brought under review and replaced by new licences where appropriate. Under the Road Vehicles and Drivers Order, 1949, the authorisations are extended until July 31, 1950. They include defence permits to use goods vehicles and permits to use a public service vehicle, operate a road passenger service, act as driver or conductor of a public service vehicle, and as driver or conductor of a tram or trolley vehicle, or as a driver of a hackney carriage in the Metropolitan Police District.

SOUTH BANK DEVELOPMENT.—In connection with the 1951 Festival of Britain, it is planned to execute certain schemes for the more convenient handling of traffic on the South Bank, between County Hall and Waterloo Bridge. One of these schemes consists of the improvement of the intersection of Waterloo Road and York Road, Lambeth, where it is proposed to provide a temporary triangular roundabout involving the construction of two new streets. One of these streets will run from the south-east side of York Road across Boyce, Whichcote and Buckley Streets, to Waterloo Road and the other from a point on the opposite side of York Road, across Tenison Street and over Howley Terrace to Waterloo Road. It will also be necessary to narrow the carriageway of part of Waterloo Road and to remove to a new position the underground convenience in that road at its junction with York Road. The estimated cost of the works is £130,000.

A HANDBOOK ON LOCOMOTIVES.—An interesting and valuable handbook recently issued by the Locomotive Manufacturers Association of Great Britain has been printed in five languages to provide a link between railwaymen in all parts of the world. This book has taken a number of years to compile and in it every nut, screw and bolt in a railway locomotive has been tabulated, indicated on specially drawn diagrams, and described in English, French, German, Spanish and Portuguese. The translations were done by locomotive engineers serving in the various countries to ensure that not only were the translations accurate but that local meanings were properly conveyed. The object of the handbook is to provide information regarding locomotive building and, in making it available throughout the world, initiate a campaign for the standardisation of terms. It provides the first complete dictionary of its kind and will enable a British locomotive engineer with a slight knowledge of a foreign language to discuss intricate engine problems fairly fluently and with confidence in that tongue. The six main sections into which the volume is divided are as follows : a history of the British locomotive industry ; the date which should be given in making enquiries ; British Standard Specifications relating to locomotives ; a dictionary in five languages ; manufacturing limits and fits, and useful technical data. In presenting the first edition of the book, the L.M.A. invites information, comment and criticism which will assist in compiling an improved second edition. The book is not for sale but will be distributed by the L.M.A. to those particularly concerned throughout the world.

Air and Water

REMOVAL OF NATIONAL AERONAUTICAL COLLECTION.—The National Aeronautical Collection in the Science Museum, South Kensington, was closed to the public on Monday, July 25th, preparatory to its removal to enable the unfinished wing of the Museum to be completed for use by the Festival of Britain in 1951. It is hoped to display the Collection at a later date in another building adjacent to the Museum.

AUSTRALIAN POWER SCHEME.—Overseas contractors will be invited to undertake the task of tunnelling for the £200 million Australian Snowy River hydro-electric power scheme, according to the Minister for Works, Mr. Nelson Lemmon. Mr. Lemmon said that equipment for the Snowy River scheme, which the Minister for Post-war Reconstruction, Mr. John Dedman, had the authority to order while abroad, included bulldozers, power shovels, rooters, scrapers, scoops, mobile cranes, and complete saw-milling equipment and various types of pumps. He went on to say that it was probable that about 4000 men would be employed on the Snowy River diversion.

SWEDISH NAVAL DESIGN.—Two new destroyers, each displacing 2,350 tons, have been designed for the Swedish Navy. These vessels will be equipped with armament said to be of a new type, with considerably increased effective power, which will include four 12cm guns in twin turrets, 57mm and 40mm automatic anti-aircraft guns, and 53cms torpedo tubes. An experimental torpedo boat has also been designed with the object of obtaining design data about the hull and engine of torpedo boats of larger size than those at present in commission. This experimental craft will have a displacement of about 140 tons and will be armed with four 53cms torpedo tubes and two 40mm guns.

Miscellanea

THE LATE MR. J. H. RUNBAKEN.—We announce with regret the sudden death on July 18th of Mr. J. H. Runbaken, the founder and managing director of Runbaken Electrical Products, Manchester. He founded the firm over forty years ago and his exceptional ability and enterprise were well known throughout the motor and electrical trades.

DIAMOND TOOL PATENTS.—The second edition of " Diamond Tool Patents Ia, for Machining Metals and Non-Metallic Substances," by P. Grodzinski and W. Jacobsohn, has recently been published. The first edition was published in 1945, containing a survey of ninety-eight patent specifications in this field. The second edition has been considerably enlarged and contains over 200 patent specifications. Further, an appendix on machines and equipment for shaping industrial diamonds has been added, containing some twenty specifications. It is published by the Industrial Diamond Information Bureau, 32–34, Holborn Viaduct, London, E.C.1, and is obtainable at a price of 10s.

NEW ZEALAND STEEL ORDERS.—New Zealand is to obtain 2500 tons of steel, required for two hydro-electric projects, from Britain, according to the Minister of Works, Mr. Semple. He said that the British Iron and Steel Corporation had promised delivery of 1300 tons of steel plate for penstocks at the Maraetai project before the end of this year and 1200 tons for penstocks at the Cobb River scheme during the first and second quarters of next year. The Minister said the New Zealand Government was inviting tenders for the fabrication of steel penstocks for the Maraetai hydro-electric power scheme, which called for the construction of 16ft diameter pipes. Earlier efforts to obtain the steel in Australia, Canada, the U.S.A., Belgium and the U.K. had failed, he added.

ROYAL STATISTICAL SOCIETY.—A provisional group of the Industrial Applications Section of the Royal Statistical Society has been successfully operating in South Wales, and meetings have been held in Crumlin, Cardiff and Swansea during the last year. A formal group, to be called the South Wales Group, has now been inaugurated under the chairmanship of Dr. T. V. Starkey, of the Technical College of Monmouthshire. The section is concerned with the application of statistical techniques to all aspects of industry, including industrial research, development and manufacture, and inspection. Further information and forms of application for membership can be obtained from Mr. E. Lloyd, at the Technical College of Monmouthshire, Crumlin. Information concerning groups already existing in Birmingham, London, Newcastle, Sheffield and Tees-side can be obtained from the Secretary of the Industrial Applications Section, Miss J. Keen, G.E.C. Research Laboratories, Wembley, Middlesex.

SECOND INTERNATIONAL MECHANICAL ENGINEERING CONGRESS.—The Second International Mechanical Engineering Congress will be held in Paris from September 12th to September 17th. The programme of the Congress includes a number of papers, some to be read in French and some in English, by engineers of various European countries. There will also be visits to various factories in the neighbourhood of Paris on each day. Various arrangements have been made to enable delegates to meet each other in a congenial atmosphere and make personal contacts with visitors from other countries. At the end of the Congress a study tour of one week will be organised, taking delegates through some of the most picturesque parts of France and allowing opportunities for visits to industrial undertakings. August 25th is the closing date for registration for the Congress, and the address of the Secretariat of the Second International Mechanical Engineering Congress is 11, Avenue Hoche, Paris (8e).

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Supervising Electrical Engineers

Tues., Aug. 2nd.—S.E. LONDON BRANCH: Castle Hotel, High Street, Eltham, "Ball and Roller Bearings," 8 p.m.

Wed., Aug. 3rd.—N. LONDON BRANCH: St. John's Hall, Hoppers Road, Palmers Green, N.13, "The A.S.E.E.," R. F. Twentyman, 8.15 p.m.

Engineering and Marine Exhibition

Thurs., Aug. 25th, to Sat., Sept. 10th.—Olympia, London.

Institute of Road Transport Engineers

Thurs., Aug. 18th.—NORTH-WEST CENTRE: Visit to the works of Leyland Motors, Ltd., Leyland, Lancs, 10.30 a.m.

Personal and Business

MR. ERIC PHILIP ASH has been elected a director of Albion Drop Forgings Co., Ltd.

DOWSETT HOLDINGS, Ltd., announces that Mr. G. H. Gunson and Colonel R. B. Emerson have been appointed directors.

BARTRAM AND ALLEN, Ltd., informs us that its head office and works is now at Ferndale Terrace, Harrow, Middlesex (telephone, Underhill 0440).

TAYLOR AND JONES, Ltd., informs us that its works at Howley, near Huddersfield, will be closed from Friday evening, August 5th, to Monday morning, August 22nd.

C. A. PARSONS AND CO., Ltd., states that Mr. Harold P. Martin, general sales manager, and Mr. W. D. Horsley, chief electrical engineer, have been appointed directors.

MR. H. A. BONNEY, secretary and general manager of Follsain-Wycliffe Foundries, Ltd., of Lutterworth, has been appointed a director of the company, retaining his former offices.

DOW-MAC (PRODUCTS), Ltd., announces that its factories at Tallington, Stamford, Lincs, and Griffiths Crossing, Caernarvonshire, will be closed from July 29th until August 8th.

RICARDO AND CO., ENGINEERS (1927), Ltd., states that its Bridge Works, Shoreham-by-Sea, Sussex, will be closed for annual holidays from the evening of August 19th to the morning of August 29th.

EASTWOODS, Ltd., formerly in occupation of the riverside wharf and head office, at 47, Belvedere Road, S.E.1, has moved to Eastwood House, 158–160, City Road, E.C.1 (telephone Clerkenwell 4333), to make room for the South Bank 1951 Exhibition.

SCOTTISH REGION of British Railways announces Mr. R. White, assistant to motive power superintendent, to be appointed district motive power superintendent, Ayr, and Mr. W. Dunsmuir, assistant to motive power superintendent, to be district motive power superintendent, Burntisland.

Contracts

THE BRUSH ELECTRICAL ENGINEERING COMPANY, Ltd., acting as sub-contractors to Vickers-Armstrongs, Ltd., has received an order to the value of over £350,000 for the main power station and all electrical equipment, including the main kiln motors, for a new United Provinces Government cement factory to be erected at Robertsganj, near Mirzapur. The plant for the power station will include three Brush-Ljungstrom turbo-alternators rated at 2400kW M.C.R. at 3300V. They will operate on steam conditions of 325 lb per square inch and 725 deg. Fah., and will each be arranged on the unit principle with a 30,000 lb per hour John Thompson water-tube boiler, complete with superheaters, stokers, economisers, induced and forced draught fans, and including water-treatment plant, feed pumps and coal and ash-handling plant.

THE ARGENTINE LINER "PRESIDENTE PERON."—With reference to the article published in last week's issue on this ship, we are informed by Peter Brotherhood, Ltd., of Peterborough, that the three 550-kW generating sets were built by that firm, and that only the generators, not the sets as a whole as we stated, were manufactured by the British Thomson-Houston Company, Ltd. The Brotherhood turbo-generating sets are supplied with steam at a pressure of 425 lb to 470 lb per square inch gauge, which is superheated to a total temperature of 700 deg. to 800 deg. Fah. The turbines exhaust into their own condensers, and the turbine speed is reduced by gears from 6000 to 1000 r.p.m.

Technical Reports

The Mechanism of Discharges in Voids in Dielectrics: Interim Report. By J. H. Mason, B.Sc., A.Inst.P. The British Electrical and Allied Industries Research Association (Ref. L/T192). Price 13s. 6d., postage 3d.—An experimental investigation of the electric stress necessary for inception of discharges in small voids in polythene has been undertaken and preliminary results are given in this report. The variation of inception stress with the depth and area of the voids, the effect of surface contamination and the magnitude of discharge at inception have been determined. The magnitude and frequency of discharge have been observed to vary with the voltage applied, the period of test and the dimensions of the void. Results are presented for discharges between plane parallel polythene surfaces and between polythene and a plane parallel metal electrode. It is suggested that several factors remain to be elucidated. These factors include ventilation of the void, formation of conducting films on the void surfaces and formation or destruction of easily emitting spots on the surfaces. Tests on ventilated voids will be carried out later.

Note on Methods of Impact Testing with Special Reference to Testing at High Velocity. By H. F. Church, B.Sc. The British Electrical and Allied Industries Research Association (Ref. L/T195). Price 6s., postage 3d.—Impact strength is usually determined by measuring the kinetic energy of a moving mass on breaking the rigidly held specimen. It is suggested that the disadvantages of this method can be overcome by testing at high and constant velocity, the energy and momentum transmitted from one moving body to another through the specimen during its fracture being recorded and related to the energy absorbed by the specimen. Methods of performing this high-velocity test are outlined, one of which could be used for impact testing in torsion.

Thermal Breakdown with Internal Defects. By S. Whitehead, M.A., Ph.D., M.I.E.E. The British Electrical and Allied Industries Research Association (Ref. L/T193). Price 9s., postage 3d.—Breakdown of solid dielectrics frequently begins by the appearance of inclusions or paths either of low electric strength or of relatively high permanent conductivity. It has frequently been suggested that thermal instability can occur in the dielectric in the neighbourhood of these defects. This thermal instability, it has been supposed, will enlarge the defect which may thus propagate itself, or, on the other hand, the dielectric will rise in temperature until a breakdown path is formed. It is the object of the present report to examine some aspects of this hypothesis.

Among the general conclusions reached in the report are that thermal instability is unlikely to arise due to a local concentration of field or of heat flow; except where special conditions exist, the defect must itself generate heat to cause thermal instability. To cause thermal instability at power frequencies a conducting film on the surface of a void or other defect must have a very high resistance. At higher frequencies coherent carbon films or other normal decomposition products can engineer thermal instability. A degree of deterioration which yields an appreciable volume having an abnormally high power factor may cause thermal instability, but this will cease if the defect subsequently becomes conducting and is thereby relieved of stress.

The Stress Dependence of the Viscosity of Bitumens. By R. A. Sack. The British Electrical and Allied Industries Research Association (Ref. L/T197/ Price 6s., postage 3d.—The previous theory of flow applicable to bitumens of the sol type is extended to calculations of the variation of the effective viscosity under tensile and compressive stresses. It is found that for steady flow the viscosity should increase under tension and decrease under compression. In practice the viscosity decreases with applied stresses irrespective of sign, and a number of suggestions are made to account for the discrepancy. Experiments are suggested to determine any difference between the effective viscosities for equal tensile and compressive stresses; the magnitude of this difference would indicate to what extent the elastic properties of bitumens are due to their solid and fluid components respectively.

The Dielectric Properties of Silicone Liquids. By E. Rushton (National Physical Laboratory). The British Electrical and Allied Industries Research Association (Ref. L/T201). Price 6s., postage 3d.—The dielectric properties of liquid silicones have been investigated over a wide range of temperature and frequency. There are marked differences in dielectric properties between the low viscosity liquid on the one hand, and the high viscosity liquids on the other. All the liquids examined showed excellent dielectric properties up to 100Mc/s, but the high viscosity liquids in particular have high power factors (of the order of 0·01) at 3000Mc/s. The silicones are polar materials, but they do not conform to the simple Debye model for liquids of relatively low viscosity where the relaxation time is directly proportional to the viscosity or chain length. The relaxation times, after increasing at first with chain length, tend towards a constant value for long chains.

The Energy Dissipated by Discharges. A note by H. Pelzer, Dr. Phil. The British Electrical and Allied Industries Research Association (Ref. L/T207). Price 3s., postage 3d.—Austen and Hackett pointed out some time ago that the energy dissipated by discharges in voids of the dielectric of a capacitor connected to an a.c. supply can be calculated in two different ways. Either the sum is taken of the energies dissipated in the single discharges or the sum of the energies taken out of the supply at the single discharges. The latter sum consists of positive and negative contributions, because energy can be stored and given back to the supply at a later discharge, whilst the first sum can obviously consist of positive contributions only; taken over a sufficient number of cycles, however, both sums must, of course, yield the same result.

As one or two notes have appeared during the last year which seem to make use of a mistaken expression for the total dissipated energy, the expressions are reproduced and an idealised example is given as illustration.

The Theory of the Control Problem of H.V. D.C. Transmission with Rectifiers and Inverters in Bridge Circuit. By Dr.-Ing. F. Busemann. British Electrical and Allied Industries Research Association (Ref. Z/T74). Price 24s., postage 5d.—This report describes the characteristics of rectifiers and inverters using valves connected in bridge circuits, the d.c. side being in series and the a.c. side in parallel. Commutation conditions are studied as far as the d.c. and 50c/s voltages are concerned, but h.f. oscillations are not dealt with. After consideration of the characteristics of rectifier and inverter stations the conditions of co-operation of both stations and the line are explained. Attention is given to the conditions of the inverter to ensure safe commutation during minor faults in the a.c. system. The limit of these minor faults is evaluated in terms of permissible voltage reductions during faults.

The Stability of Frequency of A.C. Systems Connected by a D.C. Transmission Line. By Dr.-Ing. F. Busemann. The British Electrical and Allied Industries Research Association (Ref. Z/T75). Price 9s., postage 3d.—On a high-voltage d.c. transmission system the frequency variations on the inverter side are, in practice, likely to be small whereas on the rectifier side the frequency will probably be substantially influenced by d.c. load variations. This report examines the frequency characteristics of a.c. systems connected by a d.c. transmission line.

ROAD ACCIDENTS DURING MAY.—Casualties on the roads of Great Britain during May, 1949, totalled 14,648, an increase of 3447 on May, 1948, when there was no standard petrol ration. Deaths numbered 377, an increase of 76, and the injured 14,271, an increase of 3371. The most serious increase in casualties was among motor cyclists and their passengers, of whom 87 were killed, 780 seriously injured, and 1506 slightly injured. These figures are about three and a half times the corresponding figures in May last year. The number of other drivers killed rose from 14 to 28, and seriously injured from 154 to 248. Among passengers, 47 were killed and 543 were seriously injured. The official notice points out that with the doubling of the standard petrol ration during the holiday months there has been a considerable increase in motor traffic, and more care will be needed if a further rise in casualties is to be avoided.

STEEL PRODUCTION.—During the year ended June 30, 1949, the United Steel Companies, Ltd., made more than 2,000,000 tons of steel ingots for the first time in its history, 2,042,056 tons being produced. It is said that no other British steel firm has ever equalled this production. The Appleby-Frodingham Branch at Scunthorpe made 830,000 tons of steel ingots, and the Steel, Peech and Tozer Branch at Rotherham made 761,000 tons. It is believed that no other British steelworks has made as much as either of these. Both these branches and the Samuel Fox and Co., Ltd. branch at Stocksbridge beat their previous records by substantial margins. The cogging mill at the Steel, Peech and Tozer Branch rolled almost 800,000 tons, which is believed to be a record for any one cogging mill in this country. The Templeborough melting shop at this branch made 573,000 tons of ingots and maintained its position as the largest melting shop in the country.

A Seven-Day Journal

Industrial and Domestic Coal Consumers' Councils' Reports

THE second annual reports of the Industrial and Domestic Coal Consumers' Councils, set up under the Coal Industry Nationalisation Act, have now been presented to the Minister of Fuel and Power. The reports show that during the year ended June 30, 1949, the Domestic Council dealt with ninety complaints and the Industrial Council with three. Both Councils strongly stress the need for increased fuel efficiency. The Industrial Council expresses hope for a reduction of the prices of coal, but states that, in its opinion, the main scope for enabling consumers generally to reduce fuel costs must be in increased efficiency in the use of coal and steam. It is pointed out that an increase in efficiency of 25 per cent would result in a saving of coal of at least 20 per cent in consumers' fuel costs, and that every ton of coal so saved could be used for other purposes. The Council welcomes the extension of the use of the Ministry's mobile testing unit as part of the Fuel Advisory Service. It is encouraging to note, the report says, that in the first year's operation the British Electricity Authority, in collaboration with the National Coal Board, has been able to secure that coal of a more consistent quality has been delivered to industrial stations. In some areas the dissatisfaction with the quality of industrial coal has been due to the use of opencast coal. The Council expresses the hope that great care will be taken in the selection of new sites for opencast mining operations. It is reported by the National Coal Board that during 1948 twenty-three coal cleaning plants were brought into operation, and in that year some two million more tons of dirt were removed from the coal than in the previous year 1947. The Domestic Council notes that with the increased scarcity of anthracite and steam coal for domestic heating purposes, resulting from increased export demands, it is necessary for coke to be used as the main boiler fuel wherever possible. Finally, the Council is strongly of the opinion that the most promising advance towards satisfying the consumer is by the installation of modern solid fuel appliances. The supply of such appliances, it is noted, is becoming more possible for replacing old appliances, and the Council understands that it is the intention of the Ministry to open information centres on an experimental basis and to send an exhibition van to rural areas.

Road Fund Report, 1947–48

THE Annual Report on the Administration of the Road Fund for the year ended March, 1948, which has just been published by the Stationery Office, shows that payments for all purposes from the Road Fund amounted to £26,000,000, or £9,000,000 more than in the previous year. Amounts paid for the maintenance and improvement of roads, and the construction of new ones, totalled over £24,000,000, including over £8,000,000 on trunk roads. These figures are to be compared with £15,000,000 and £7,000,000 respectively in the previous year. At the end of March, 1948, the mileage of trunk roads was about 8000. During the year over £7,000,000 was spent on maintenance and minor improvements, including the resurfacing of about 673 miles and the surface dressing of about 13,400,000 square yards. Two air surveys were completed, which covered about 80 miles of principal national routes, while in addition extensive preliminary survey and road location work was carried out in connection with proposed trunk roads. Local highway authorities maintained local roads to a reasonable standard within the limits which restricted funds permitted. Roads were restored in East Anglia and in Scotland, and schemes to increase safety, such as the improvement of camber and the provision of superelevation on bends, and for the better regulation of traffic, were also carried out. Five level crossings were eliminated. Two bridges, one over the Tyne at Newburn, in Northumberland, and the other at Cookham, in Berkshire, were freed from tolls, and about 27 miles of tramway were abandoned. The report states that many bridges on main through routes are inadequate. Long-term schemes for the improvement of these bottlenecks have had to be postponed for reasons of capital expenditure, but progress is being made in connection with a short-term programme drawn up in 1946–1947 for dealing with those bridges on through routes which most urgently need attention. Among the cuts in capital investment announced by the Government in 1948 were the curtailment or postponement of a large number of road works and the reduction of road maintenance work in order to allow for the release of 20,000 men for more urgent work, out of a total labour force of 90,000. The cuts, however, made little difference to the volume of work dealt with in this report, as they relate to work to be done in 1948 and afterwards.

Advisory Council on Scientific Policy Report

THE second annual report of the Advisory Council on Scientific Policy has now been published by the Stationery Office. It will be recalled that the terms of reference of this Council are "to advise the Lord President of the Council in the exercise of his responsibility for the formulation and execution of Government scientific policy." The present report covers the period of twelve months from March 12, 1948. It refers to the action taken in connection with its first report, and also its recommendations, which were embodied in a special report issued on June 25, 1948, in which it was stressed that the primary need was for more men who had reached University Honours Degree standard in fundamental science, to be given post-graduate education in applied science. Consideration, it was stated, should be given to the possibility of sending up to 100 men a year for full courses at the best technological institutions abroad. Steps have been taken by the University Grants Committee and the National Advisory Council on Industry and Commerce to bring about some of these developments, and the University Grants Committee proposes to recommend the establishment of facilities for higher work in technology at a small number of universities. In connection with industrial efficiency, the Advisory Council on Scientific Policy has recommended that a scientific investigation into the validity of work study, embracing method, motion and time studies, should be carried out as soon as possible, and the Nuffield Foundation has agreed to sponsor that work. The report states that there is still a shortage of suitably qualified scientists for the needs of both the Government and industry. The present, it is felt, is a period of consolidation, until the far larger number of graduates in science and engineering, who are expected from the expansion of the universities, make new developments desirable and possible. The report lays special emphasis upon the importance of applying science in the most efficient manner possible as a basis of our future prosperity. It is considered that the high level of productivity in the United States, and the considerable industrial prosperity of certain European countries, even without our advantages, are largely due to the greater importance which they attach to the employment in industry of men who have received an education of university standard in technology. In the long run, the report concludes, our own precarious position cannot be expected to improve unless our industries employ a sufficient number of men adequately trained to apply and develop the discoveries of pure research.

Lord McGowan on Standardisation

AT the forty-eighth annual general meeting of the British Standards Institution last week, the President, Lord McGowan, K.B.E., referred to the greatly increased interest during the past year both by industry and Government in the extension of voluntary standardisation on a national basis. The investigations by the Committee for Standardisation of Engineering Products under the chairmanship of Sir Ernest Lemon, set up by the Ministry of Supply, had substantiated the view, long held by British industry, that the principles under which the B.S.I. works are effective and can be considerably extended. The Anglo-American Productivity Council had recently stressed the importance of standardisation and simplified practice, and Lord McGowan submitted that there was probably no more effective means for increasing productivity. Another significant development during the past year was the co-operation of the great nationalised industries with the B.S.I. and the increase in the collaboration amongst large industrial users, with a view to assisting manufacturers to reduce the number of types and sizes. This progressive standardisation would, it was felt, greatly assist the economy of the country by enabling manufacturers to introduce longer runs and better production methods in their operations. In conclusion, Lord McGowan said that the B.S.I. was the pioneer national standards organisation. It collaborated with thirty-four other standard bodies oversea. With the continued growth in the number of export and import controls exercised by various countries national standards were becoming increasingly important. Mr. Roger Duncalfe, the Chairman of the Institution, said that Government and industry had jointly agreed that industrial standardisation should be effected through the B.S.I. as the national standards body and that "industry" included all the great professional institutions. Sir William J. Larke, K.B.E., was elected the new President of the Institution.

The National Coal Board

IN the course of an address given at the Liberal Summer School at Oxford on Monday, August 1st, Sir Charles Reid, a former member of the National Coal Board, dealt with changes in the policy and organisation of the Board, which he held were needed if a better spirit and a greater sense of responsibility was to be brought back to all ranks in the coal mining industry. Since the vesting day some progress had, he said, been recorded. The attitude of the men's leaders had changed for the better, the closure of uneconomic pits had been agreed to, the men's demands for more pay and other concessions had been largely granted, and there was no lack of money for new coal face machinery. While it was claimed that the output per man-shift now equalled that of before the war, that equality had been achieved by an increase in machinery rather than by any increased effort on the part of the men. For many years a large proportion of the men had been unhappy. Nationalisation had now come and had brought with it higher wages and other important concessions, all very costly to the State; but the energy of which the men were capable had not been released. Their work remained, in far too many cases, as uninspired and grudging as before. Sir Charles claimed that the initiative of the Divisional Boards was constantly stultified by the necessity to consult London about matters which they could decide for themselves. It was little short of a tragedy that the best mining engineers in the country, now occupying the position of divisional production directors, should be spending their time in the hopeless task of trying to guide the mining technique of collieries producing in total 30 or 40 million tons of coal a year, and attempting to examine the monthly costs of 150 collieries, with no authority to give an order and no responsibility for either output or costs. Sir Charles Reid said that he advocated a policy-making body with full managerial powers delegated to twenty-six or more coal corporations. By such means a better spirit would, he felt, be brought into all ranks, with a greater sense of responsibility.

Behaviour of Cast Steel at Elevated Temperatures*

No. II—(*Continued from page 128, July 29th*)

By A. E. JOHNSON, M.Sc., A.M.I. Mech. E.†

TABLES I, II and III respectively give the experimental values for the axial and circumferential creep rates in the various tests at 150 hours for 350 deg. and 450 deg. Cent., and at 100 hours for 550 deg. Cent. At the latter temperature the period of 100 hours was chosen on account of the fact that several of the curves at higher stresses for all stress systems reached their minimum rate at about 100 hours and commenced their entry into the third portion of the creep curve at about 150 hours.

These creep rate values for the three temperatures were plotted on a double logarithmic scale for the ranges of creep rate 3×10^{-8} to 5×10^{-7} at 350 deg. Cent., 5×10^{-8} to 10^{-7} at 450 deg. Cent., and of 10^{-7} to 2×10^{-6} at 550 deg. Cent. The mean curves were drawn and corrected values of the axial and circumferential rates obtained from them. These corrected values were subsequently used to compute the principal and octahedral creep rates, and are given in Tables I, II and III. This measure was taken to minimise the effect of error in individual cases. In ranges of strain higher than those mentioned above, where only a few tests were made in all, and consequently a mean curve could not with experimental values without further correction.

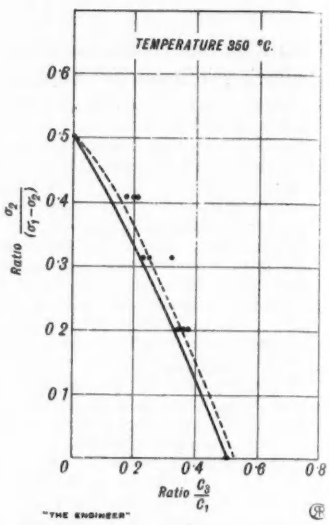
The values of the principal and octahedral creep rates given in Tables I, II and III have been computed for test periods of 150 hours at 350 deg. and 450 deg. Cent. and 100 hours at 550 deg. Cent., making use of the equations given earlier in the paper.

The principal creep rates and octahedral rates at other periods may be computed from the ratios given above.

Two points are worthy of notice in connection with the results in Tables I, II and III. It will be noted that at no temperature is any axial creep shown in the pure torsion creep tests. This, in the author's opinion, offers strong evidence that the creep on a plane is unaffected by the stress acting normally to it. If it has been possible to show that a hydrostatic stress makes no difference to the creep of a stress system for this material the evidence would be conclusive, but since the author's work was inherently incapable of providing this additional evidence the conclusion must be tentative.

Secondly, except in one or two cases only the creep in direction of wall thickness is negative. The few exceptional cases are at high stresses where considerable initial plastic strain occurs on loading.

(8) *Consideration of the Degree of Anisotropy of the Material at the Various Temperatures.*—As previously indicated in this report, creep tests at 450 deg. Cent. and 6 tons per square inch on solid specimens taken in three rectangular directions from the original billet indicated that the creep characteristics of the material were closely similar in the three directions, and reasonably isotropic



●● Experimental points
——— Curve corresponding to equations of the types $C_1=A[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)]$ and $C_1=A[(\sigma_1-\sigma_2)^3-(\sigma_3-\sigma_1)^3]$ &c.
— — — — Curve corresponding to equations of the type $C_1=[A(\sigma_1-\sigma_2)-C(\sigma_3-\sigma_1)]$, &c. For $A=B=0\cdot91C$

FIG. 10

behaviour in subsequent tests on tubular specimens was therefore to be expected.

However, in carrying out the first set of tests on tubular specimens (at 450 deg. Cent.) for stress systems having a value of p/q up to 1·5 it became evident (see Fig. 11) on plotting the stress function

$$-\sigma_2/(\sigma_1-\sigma_2)$$

against the strain function $-C_2/C_1$ that for the stress combination $p/q=1\cdot5$, and values of p/q above, the trend of the curve for the experimental results would be somewhat

TABLE I—*Results of Pure Tension, Pure Torsion and Complex Stress Creep Tests on 0·17 per cent C Steel at 350 deg. Cent., Compared with Values Computed from Theoretical Considerations. All Values at 150 Hours*

Tensile stress, p, tons/sq in	Torsion stress, q, tons/sq in	Principal stress, σ_1	Principal stress, σ_2	Octahedral shear stress, σ_o, tons/sq in	Axial creep rate, in/in/hr × 10^6	Circumferential creep rate, in/in/hr × 10^6	Axial creep rate corrected to mean curve, in/in/hr × 10^6	Circumferential creep rate corrected to mean curve, in/in/hr × 10^6
		$\sigma_3=0$, Throughout, tons/sq in						
26	—	26	—	12·25	68	—	—	—
18	—	18	—	8·5	5·9	—	—	—
14	—	14	—	6·6	1·7	—	—	—
10	—	10	—	4·72	0·375	—	0·375	—
8	—	8	—	3·77	0·185	—	0·195	—
6	—	6	—	2·83	0·19	—	0·09	—
4	—	4	—	1·88	0·032	—	0·028	—
—	10	10	−10	8·17	—	7·3	—	—
—	8	8	− 8	6·53	—	1·85	—	—
—	7	7	− 7	5·72	—	0·8	—	0·82
—	6·02	6·02	− 6·02	4·92	—	$0\cdot42_5$	—	0·50
—	5·91	5·91	− 5·91	4·83	—	0·45	—	0·46
—	5·04	5·04	− 5·04	4·12	—	0·33	—	0·30
—	3	3	3	2·45	—	0·068	—	0·066
4	10	12·2	− 8·2	8·4	0·76	7·6	—	—
3	7·5	9·15	− 6·15	6·3	0·25	2·1	0·26	1·7
2	5	6·1	− 4·1	4·2	0·09	$0\cdot38_5$	0·08	0·5
1·4	3·5	4·27	− 2·87	2·94	0·028	0·22	0·028	0·18
8	10	14·75	− 6·75	9	1·58	10·0	—	—
6	7·5	11·1	− 5·08	6·73	0·58	3·7	—	—
4·8	6	8·87	− 4·05	5·4	0·31	1·0	0·25	0·83
3	3·75	5·53	− 2·53	3·37	0·047	$0\cdot18_5$	0·062	$0\cdot22_5$
2	2·5	3·7	− 1·69	2·25	0·024	0·08	0·019	0·07
12	8	16	− 4	8·6	2·05	6·4	—	—
9	6	12	− 3	6·43	0·57	2·1	0·63	1·5
6·75	4·5	9	− 2·25	4·83	0·17	0·5	$0\cdot26_5$	0·51
4·5	3	6	− 1·5	3·22	0·09	$0\cdot17_5$	0·089	0·18
3	2	4	− 1	2·14	0·03	0·06	0·029	0·056

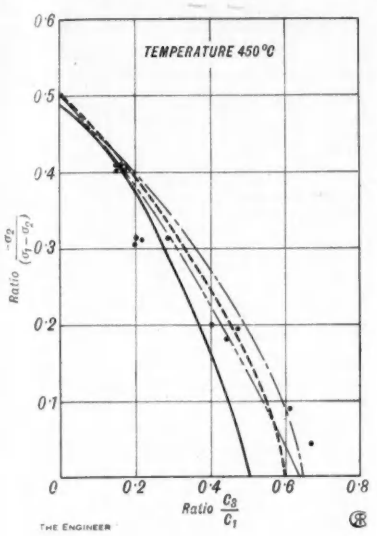
$\sigma_o=1/3[\Sigma(\sigma_1-\sigma_2)^2]^{\frac{1}{2}}$. $C_o=2/3[\Sigma(C_1-C_2)^2]^{\frac{1}{2}}$.

confidence be drawn, the principal and octahedral rates are directly computed from the

* Report J/T 137, The British Electrical and Allied Industries Research Association. The full title is "The Behaviour of a Nominally Isotropic 0·17 per cent C Cast Steel Under Combined Stress Systems at Elevated Temperatures."

† National Physical Laboratory.

away from the value of $-C_3/C_1=0\cdot5$ corresponding for pure tension to a state of isotropy. Further tests at stress systems corresponding to higher values of p/q consequently necessary to take this consideration into account in analysing the results of the work.



●● Experimental points
——— Curve corresponding to equations of type $C_1=A[(\sigma_1-\sigma_2)^{1\cdot9}-(\sigma_3-\sigma_1)^{1\cdot9}]$ and &c.
— — — Curve corresponding to equations of type $C_1=[A(\sigma_1-\sigma_2)^{1\cdot9}-C(\sigma_3-\sigma_1)^{1\cdot9}]$, &c., where $B=C=1\cdot5A$
- — — - Curve corresponding to equations of type $C_1=[A(\sigma_1-\sigma_2)^{1\cdot9}-C(\sigma_3-\sigma_1)^{1\cdot9}]$, where $B=2A$ and $C=1\cdot8A$
- - —— - - Curve corresponding to equations of type $C_1=[\Sigma(\sigma_1-\sigma_2)]^{0\cdot45}[A(\sigma_1-\sigma_2)-C(\sigma_3-\sigma_1)]$ where $B=C=1\cdot7A$

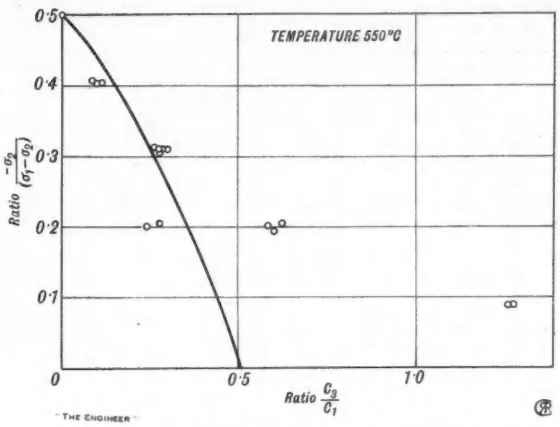
FIG. 11

Consideration of results of the tests at 350 deg. Cent. indicated a close approach to isotropy at all except the highest stresses. At this temperature (in contrast to the position at 450 deg. and 550 deg. Cent.) it was possible in virtue of the small oxidation to measure the circumferential and wall thickness strains of a tensile specimen directly. In such a test at 18 tons per square inch the longitudinal strain was 1·44 per cent at 150 hours, the diametrical strain 0·72 per cent, and the wall thickness strain 0·69 per cent. In other words, the lateral strains were roughly half the longitudinal strain, which is in accordance with conditions of isotropy, but, as will be seen later, is not a complete criterion of isotropy. Again, for moderate and lower stresses the plot of

$$-\sigma_2/(\sigma_1-\sigma_2)$$

against $-C_3/C_1$ (see Fig. 10) for this temperature shows a trend corresponding with isotropy for combinations approaching pure tension.

At high stresses at both 350 deg. and 450 deg. Cent. positive wall thickness creep occurred, indicating anisotropy of a special type, which appears to be due to the effect of the relatively high initial plastic strains occurring at these stresses. Apparently preferred hardening arises under these circumstances which considerably modifies the subsequent creep. Rotation of grains may occur. The nature of this type of anisotropy is discussed fully in a later paragraph.



O O Experimental points
——— Curve corresponding to equations of type $C_1=A[(\sigma_1-\sigma_2)^{2\cdot1}-(\sigma_3-\sigma_1)^{2\cdot1}]$, &c.

FIG. 12

At 550 deg. Cent. very considerable departure from isotropy appeared to occur. The trend of the curve between the functions

$$-\sigma_2/(\sigma_1-\sigma_2),$$

and $-C_3/C_1$ is very far from being toward the tensile value of 0·5 (Fig. 12). The value indeed for the stress system $p/q=3$ is roughly 1·26. The results appeared to indicate that at this temperature the degree of anisotropy firmed this view, the extrapolated value of $-C_3/C_1$ corresponding to pure tension being between 0·6 and 0·7.

It was obvious, therefore, that some degree of anisotropy occurred in the material under strain at this temperature, and it was exhibited depended upon the precise stress system used.

Evidently for the present material the degree and nature of anisotropy changes with the temperatures of test.

Since the material had proved to be iso-

TABLE I—(*continued*)

Principal creep rates (experimental N.P.L.), in/in/hr × 10⁶			Octahedral shear creep rate (experimental N.P.L.), in/in/hr × 10⁶	Principal creep rates			Principal creep rates			Principal creep rates		
				Group A*			Group B†			Group C‡		
C_1	C_2	C_3	C_0	C_1	C_2	C_3	C_1	C_2	C_3			
68	−34	−34	96	—	—	—	—	—	—	40·3	−21·5	−21·5
5·9	− 2·95	− 2·95	8·32	—	—	—	—	—	—	5·8	− 2·9	− 2·9
1·7	− 0·85	− 0·85	2·47	—	—	—	—	—	—	1·8	− 0·89	− 0·89
0·38	− 0·19	− 0·19	0·53	0·38	−0·19	−0·19	0·34	−0·17	−0·17	0·46	− 0·23	− 0·23
0·20	− 0·10	− 0·10	0·28	0·19	−0·095	−0·095	0·17	−0·085	−0·085	0·20	− 0·10	− 0·10
0·089	− 0·045	− 0·045	0·13	0·081	−0·041	−0·041	0·073	−0·037	−0·037	0·079	− 0·04	− 0·04
0·028	− 0·014	− 0·014	0·04	0·024	−0·012	−0·012	0·022	−0·011	−0·011	0·022	− 0·011	− 0·011
3·65	− 3·65	0	5·95	—	—	—	—	—	—	4·13	− 4·13	0
0·93	− 0·93	0	1·52	—	—	—	—	—	—	1·48	− 1·48	0
0·41	− 0·41	0	0·67	0·57	−0·57	0	0·51	−0·51	0	0·84	− 0·84	0
0·25	− 0·25	0	0·41	0·37	−0·37	0	0·34	−0·34	0	0·46	− 0·46	0
0·23	− 0·23	0	0·38	$0\cdot34_5$	$-0\cdot34_5$	0	$0\cdot31_5$	$-0\cdot31_5$	0	0·43	− 0·43	0
0·15	− 0·15	0	0·25	0·22	−0·22	0	0·20	−0·20	0	0·24	− 0·24	0
0·033	− 0·033	0	0·054	0·045	−0·045	0	0·04	−0·40	0	0·043	− 0·043	0
3·49	− 4·25	+ 0·76	6·4	—	—	—	—	—	—	5·0	− 4·4	− 0·62
0·95	− 0·78	− 0·175	1·43	0·82	−0·72	−0·10	0·74	−0·65	−0·09	1·33	− 1·17	− 0·16
0·29	− 0·23	− 0·06	0·42	0·24	−0·21	−0·03	0·22	−0·19	−0·03	0·27	− 0·24	− 0·033
0·10	− 0·08	− 0·02	0·15	0·083	−0·073	−0·01	0·075	−0·066	−0·009	0·08	− 0·07	− 0·01
4·95	− 5·79	+ 0·84	8·84	—	—	—	—	—	—	7·4	− 5·8	− 1·64
1·83	− 2·15	+ 0·32	3·28	—	—	—	—	—	—	1·87	− 1·46	− 0·41
0·53	− 0·36	− 0·17	0·77	0·54	−0·42	−0·12	0·49	−0·38	−0·11	0·73	− 0·57	− 0·16
0·14	− 0·105	− 0·035	0·20	0·13	−0·10	−0·028	0·12	−0·09	−0·026	0·13	− 0·10	− 0·03
0·043	− 0·033	− 0·01	0·08	0·04	−0·03	−0·01	0·036	−0·027	−0·009	0·037	− 0·029	− 0·008
3·65	− 4·35	+ 0·70	6·6	—	—	—	—	—	—	6·12	− 4·1	− 2·04
1·0	− 0·87	− 0·14	1·54	0·96	−0·64	−0·32	0·86	−0·58	−0·28	1·59	− 1·06	− 0·53
0·39	− 0·25	− 0·144	0·56	0·4	$-0\cdot26_5$	$-0\cdot13_5$	0·36	−0·24	−0·12	0·50	− 0·34	− 0·16
0·134	− 0·089	− 0·045	0·29	0·12	−0·081	−0·039	0·11	−0·072	−0·036	0·12	− 0·029	− 0·039
0·044	− 0·028	− 0·016	0·066	0·036	−0·024	−0·012	0·033	−0·022	−0·011	0·033	− 0·022	− 0·011

* Based on equations of type $C_1=A[\Sigma(\sigma_1-\sigma_2)^2](2\sigma_1-\sigma_2)$, etc., where $A=0\cdot94\times10^{-10}$ in/in/hr × 10⁶. (Best fit of tensile results.)

† Based on equations of type $C_1=A[\Sigma(\sigma_1-\sigma_2)^2](2\sigma_1-\sigma_2)$, etc., where $A=0\cdot85\times10^{-10}$ in/in/hr × 10⁶. (Best fit of results in general.)

‡ Based on equations of type $C_1=[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)]\,[\Sigma A(\sigma_1-\sigma_2)^2+A'(\Sigma(\sigma_1-\sigma_2)^2)^{2\cdot5}]$ where $A=0\cdot85\times10^{-10}$ and $A'=1\cdot0\times10^{-14}$ in/in/hr × 10⁶.

TABLE II—*Results of Pure Tension, Pure Torsion, and Complex Stress Creep Tests on 0·17 per cent Carbon Steel at 450 deg. Cent., Compared with Values Computed from Theoretical Considerations. All Values are 150 Hours*

Tensile stress, p, tons/sq in	Torsion stress, q, tons/sq in	Principal strains, σ_1	Principal strains, σ_2	Octahedral shear stress, σ_0 tons/sq in	Axial creep rate, in/in/hr $\times 10^6$	Circumferential creep rate, in/in/hr $\times 10^6$	Axial creep rate corrected to mean curve, in/in/hr $\times 10^6$	Circumferential creep rate corrected to mean curve, in/in/hr $\times 10^6$	Principal creep rate (experimental N.P.L.), in/in/hr $\times 10^6$ C_1	C_2	C_3	Octahedral shear creep rate (experimental N.P.L.), C_0 in/in/hr $\times 10^6$
		$\sigma_3 = 0$ throughout, tons/sq in										
14	—	14	—	6·6	22·7	—	—	—	22·7	$-11\cdot3_5$	$-11\cdot3_5$	32·1
12	—	12	—	5·65	14·6	—	—	—	14·6	− 7·3	− 7·3	20·7
10	—	10	—	4·72	4·1	—	—	—	4·1	$-2\cdot0_5$	$-2\cdot0_5$	5·8
8	—	8	—	3·77	1·55	—	—	—	1·55	$-0\cdot77_5$	$-0\cdot77_5$	2·19
6	—	6	—	2·83	0·41	—	0·45	—	$0\cdot42_5$	− 0·21	− 0·21	0·6
4	—	4	—	1·89	0·21	—	$0\cdot20_5$	—	$0\cdot20_5$	$-0\cdot10_5$	$-0\cdot10_5$	0·29
3	—	3	—	1·41	0·116	—	0·116	—	0·116	− 0·058	− 0·058	0·164
1·8	—	1·8	—	0·85	0·043	—	0·043	—	0·043	− 0·022	− 0·022	0·061
—	5·32	5·32	−5·32	4·35	—	3·14	—	—	1·57	− 1·57	0	2·57
—	4·22	4·22	−4·22	3·45	—	1·32	—	1·13	$0\cdot56_5$	− 0·565	0	0·92
—	$3\cdot18_5$	$3\cdot18_5$	$-3\cdot18_5$	2·61	—	0·63	—	0·63	$0\cdot31_5$	$-0\cdot31_5$	0	0·51
—	2·13	2·13	−2·13	1·74	—	0·305	—	$0\cdot31_5$	0·16	− 0·16	0	0·26
—	1·67	1·67	−1·67	1·365	—	0·157	—	0·19	0·095	$-0\cdot09_5$	0	$0\cdot15_5$
—	7·06	7·06	−7·06	5·76	—	10·6	—	—	5·3	− 5·3	0	8·7
3·15	7·78	9·53	−6·37	6·5	3·85(*M*)	41·5(*M*)	—	—	20·9	−21·4	+ 0·5	34·7
2·01	5·08	$6\cdot18_5$	−4·18	4·28	0·216	2·05	—	—	1·06	$-1\cdot03_5$	$-0\cdot02_5$	1·7
1·69	4·27	5·2	−3·5	3·57	0·159	1·01	0·154	1·04	0·58	− 0·48	− 0·10	$0\cdot92_5$
1·30	3·25	3·97	−2·67	2·72	0·081	0·58	0·087	0·61	0·34	− 0·29	− 0·05	$0\cdot53_5$
0·90	2·17	2·67	−1·77	1·82	0·041	0·29	0·043	0·29	0·16	− 0·13	− 0·03	$0\cdot24_5$
0·64	1·50	1·85	−1·21	1·26	$0\cdot021_5$	0·15	$0\cdot021_5$	0·15	0·08	− 0·068	− 0·013	$0\cdot12_5$
5·08	6·3	9·31	−4·23	5·65	2·0	8·7	—	—	4·95	− 4·42	− 0·53	7·7
3·2	4·08	5·98	−2·78	3·63	$0\cdot31_5$	1·18	—	—	0·72	− 0·55	− 0·17	1·13
2·4	3·04	4·48	−2·08	2·73	$0\cdot13_5$	0·49	0·137	0·53	0·32	− 0·25	− 0·07	0·45
1·71	2·17	3·20	−1·48	1·95	0·067	$0\cdot24_5$	0·072	0·28	0·17	$-0\cdot13_5$	$-0\cdot03_5$	0·25
1·23	1·54	$2\cdot27_5$	$-1\cdot04_5$	1·38	0·039	0·15	$0\cdot038_5$	0·14	0·087	− 0·066	− 0·021	0·13
0·83	1·03	1·53	−0·70	0·93	0·010	0·07	0·019	0·066	$0\cdot041_5$	− 0·030	− 0·012	0·06
7·72	5·0	10·19	−2·47	5·45	2·71	6·8	—	—	4·38	− 4·19	− 0·19	7·0
4·62	3·07	6·15	−1·53	3·31	$0\cdot31_5$	$0\cdot66_5$	0·34	0·62	0·49	− 0·29	− 0·20	0·7
3·24	2·11	4·28	−1·0	2·30	0·19	0·29	0·165	0·29	0·24	− 0·13	− 0·11	0·34
1·59	1·02	2·09	−0·50	1·12	$0\cdot035_5$	0·058	0·040	0·069	0·057	− 0·03	− 0·027	0·12
3·33	1·11	3·65	−0·33	1·81	0·16	0·14	—	—	0·18	− 0·07	− 0·11	0·26
6·52	1·47	6·83	−0·31	3·29	0·58	0·34	—	—	0·62	− 0·21	− 0·41	0·89

TABLE II—(*continued*)

Principal creep rates Group A* C_1	C_2	C_3	Principal creep rates Group B† C_1	C_2	C_3	Principal creep rates Group C‡ C_1	C_2	C_3	Principal creep rates Group D§ C_1	C_2	C_3	Principal creep rates Group E‖ C_1	C_2	C_3	Principal creep rates Group F¶ C_1	C_2	C_3
13·9	−5·6	−8·3	—	—	—	—	—	—	14·1	−5·2	−8·9	—	—	—	16·65	−6·17	−10·45
$6\cdot3_5$	$-2\cdot5_5$	−3·8	—	—	—	—	—	—	6·4	−2·4	−4·0	—	—	—	7·41	−2·74	− 4·67
$2\cdot7_9$	−1·11	−1·68	—	—	—	—	—	—	2·75	−1·03	−1·72	—	—	—	3·06	−1·13	− 1·93
1·21	−0·48	−0·74	—	—	—	—	—	—	1·18	−0·44	−0·74	—	—	—	$1\cdot25_5$	−0·47	− 0·79
0·53	−0·21	−0·32	0·45	−0·18	−0·27	$0\cdot43_5$	−0·16	$-0\cdot27_5$	$0\cdot51_5$	−0·19	$-0\cdot32_5$	0·43	−0·16	−0·27	0·53	−0·20	− 0·33
0·22	−0·086	−0·13	0·21	−0·084	−0·125	0·20	−0·074	$-0\cdot12_5$	0·21	−0·078	−0·13	0·20	−0·075	−0·126	0·21	−0·08	− 0·12
0·12	−0·05	−0·07	0·12	−0·048	−0·073	0·116	−0·043	−0·073	0·117	−0·044	−0·073	0·116	−0·043	−0·073	0·117	−0·044	− 0·073
0·046	−0·018	−0·028	0·046	−0·018	−0·028	0·044	−0·016	−0·028	0·044	−0·016	−0·028	0·044	−0·016	−0·028	0·044	$-0\cdot016_5$	$-0\cdot027_5$
1·47	−1·47	0	—	—	—	—	—	—	1·56	−1·56	0	—	—	—	1·51	−1·51	0
0·67	−0·67	0	0·485	$-0\cdot48_5$	0	0·50	−0·50	0	0·70	−0·70	0	0·48	−0·48	0	0·68	−0·68	0
0·32	−0·32	0	$0\cdot28_5$	$-0\cdot28_5$	0	$0\cdot29_5$	$-0\cdot29_5$	0	0·33	−0·33	0	0·28	−0·28	0	0·32	−0·32	0
0·13	−0·13	0	0·13	−0·13	0	$0\cdot13_5$	$-0\cdot13_5$	0	0·14	−0·14	0	0·13	−0·13	0	0·13	−0·13	0
$0\cdot08_5$	$-0\cdot08_5$	0	$0\cdot08_5$	$-0\cdot08_5$	0	0·09	−0·09	0	0·086	−0·086	0	0·082	−0·082	0	0·082	−0·082	0
5·1	−5·1	0	—	—	—	—	—	—	5·6	−5·6	0	—	—	—	5·32	−5·32	0
10·7	−8·6	−2·05	—	—	—	—	—	—	11·5	−9·65	−1·9	—	—	—	10·64	−8·85	− 1·78
1·51	−1·22	−0·29	—	—	—	—	—	—	1·57	−1·31	−0·26	—	—	—	1·51	−1·26	− 0·25
0·83	−0·67	−0·16	0·57	−0·46	−0·11	0·58	$-0\cdot48_5$	$-0\cdot09_5$	$0\cdot85_5$	$-0\cdot71_5$	−0·14	0·56	$-0\cdot046_5$	−0·09	0·89	−0·75	− 0·14
0·39	−0·32	−0·074	0·34	−0·28	−0·06	0·36	−0·30	−0·06	0·40	$-0\cdot33_5$	$-0\cdot06_5$	$0\cdot33_5$	−0·28	−0·055	0·40	−0·33	− 0·07
$0\cdot16_5$	−0·135	−0·032	0·16	−0·13	−0·03	0·16	−0·133	−0·03	0·167	−0·139	−0·028	$0\cdot15_5$	−0·13	−0·027	0·16	−0·133	− 0·027
0·08	−0·065	−0·016	0·079	−0·063	−0·016	0·08	−0·066	−0·014	$0\cdot080_5$	$-0\cdot066_5$	−0·014	0·077	−0·063	−0·014	0·077	−0·063	− 0·014
5·53	−3·72	−1·81	—	—	—	—	—	—	5·86	−4·15	−1·71	—	—	—	5·72	−4·06	− 1·66
—	—	—	—	—	—	—	—	—	0·67	−0·48	−0·19	—	—	—	—	—	—
0·94	−0·66	−0·29	0·37	−0·25	−0·12	$0\cdot36_5$	−0·26	−0·105	0·43	−0·30	$-0\cdot12_5$	—	—	—	0·94	−0·67	− 0·27
$0\cdot42_5$	−0·29	−0·135	0·20	−0·13	−0·07	$0\cdot19_5$	$-0\cdot13_5$	−0·058	0·20	−0·145	−0·055	0·35	−0·25	−0·10	0·41	−0·29	− 0·12
0·20	−0·14	−0·065	0·098	−0·067	−0·031	0·10	−0·072	−0·029	0·103	−0·072	−0·03	$0\cdot18_5$	$-0\cdot13_5$	$-0\cdot05_5$	$0\cdot19_5$	−0·139	− 0·056
0·098	−0·067	−0·031	0·048	−0·032	−0·016	0·047	−0·033	−0·014	0·047	−0·034	−0·014	0·098	−0·069	−0·029	0·099	−0·07	− 0·029
0·048	−0·032	−0·016	—	—	—	—	—	—	5·2	−2·9	−2·3	0·046	−0·033	−0·013	0·046	$-0\cdot032_5$	$-0\cdot013_5$
5·13	−2·75	−2·38	0·57	−0·34	−0·24	0·56	−0·32	−0·24	0·76	−0·43	−0·33	—	—	—	5·42	−3·05	− 2·37
0·76	−0·41	−0·35	$0\cdot28_5$	−0·15	$-0\cdot13_5$	$0\cdot27_8$	$-0\cdot15_5$	−0·12	0·30	−0·17	−0·13	$0\cdot54_5$	−0·31	$-0\cdot23_5$	0·75	−0·43	− 0·32
0·29	−0·15	−0·13	0·071	−0·039	−0·032	0·071	−0·04	−0·031	0·071	−0·04	−0·031	0·27	−0·15	−0·12	0·29	−0·16	− 0·13
0·07	−0·039	−0·031	0·19	$-0\cdot08_5$	−0·105	0·18	−0·081	−0·10	0·187	−0·083	−0·104	0·069	−0·039	−0·03	0·069	−0·039	− 0·030
—	—	—	0·60	−0·25	−0·35	0·58	−0·24	−0·34	0·78	−0·32	−0·46	—	—	—	—	—	—
0·19	−0·086	−0·104	—	—	—	—	—	—	—	—	—	—	—	—	0·187	−0·083	− 0·104
0·79	−0·33	−0·46	—	—	—	—	—	—	—	—	—	—	—	—	0·804	−0·329	− 0·475

M = minimum rate, $\sigma_0 = 1/3\,[\Sigma(\sigma_1-\sigma_2)^2]^{\frac{1}{2}}$, $C_0 = 2/3\,[\Sigma(C_1-C_2)^2]^{\frac{1}{2}}$.

* Based on equations of type $C_1 = \{A + A'[\Sigma(\sigma_1-\sigma_2)^2]^2\}[(\sigma_1-\sigma_2)^{1\cdot9} - 1\cdot5(\sigma_3-\sigma_1)^{1\cdot9}]$, &c., where $A = 0\cdot6\times10^{-8}$; $A' = 2\times10^{-13}$, in/in/hr $\times 10^6$.

† Based on equations of type, $C_1 = A[(\sigma_1-\sigma_2)^{1\cdot9} - 1\cdot5(\sigma_3-\sigma_1)^{1\cdot9}]$, &c., where $A = 0\cdot6\times10^{-8}$, in/in/hr $\times 10^6$.

‡ Based on equations of type $C_1 = A[\Sigma(\sigma_1-\sigma_2)]^{0\cdot45}[(\sigma_1-\sigma_2) - 1\cdot7(\sigma_3-\sigma_1)]$, &c., where $A = 0\cdot39\times10^{-8}$, in/in/hr $\times 10^6$.

§ Based on equations of type $C_1 = \{A[\Sigma(\sigma_1-\sigma_2)^2]^{0\cdot45} + A'[\Sigma(\sigma_1-\sigma_2)^2]^{2\cdot45}\}[(\sigma_1-\sigma_2) - 1\cdot7(\sigma_3-\sigma_1)]$, where $A = 0\cdot39\times10^{-8}$, and $A' = 1\cdot4\times10^{-13}$, in/in/hr $\times 10^6$.

‖ Based on equations of type $C_1 = A[(\sigma_1-\sigma_2)^2 + 1\cdot7(\sigma_2-\sigma_3)^2 + 1\cdot7(\sigma_3-\sigma_1)^2]^{0\cdot45}[(\sigma_1-\sigma_2) - 1\cdot7(\sigma_3-\sigma_1)]$, &c., where $A = 0\cdot34\times10^{-8}$, in/in/hr $\times 10^6$.

¶ Based on equations of type $C_1 = \{A[(\sigma_1-\sigma_2)^2 + 1\cdot7(\sigma_2-\sigma_3)^2 + 1\cdot7(\sigma_3-\sigma_1)^2]^{0\cdot45} + A'[(\sigma_1-\sigma_2)^2 + 1\cdot7(\sigma_2-\sigma_3)^2 + 1\cdot7(\sigma_3-\sigma_1)^2]\}[(\sigma_1-\sigma_2) - 1\cdot7(\sigma_3-\sigma_1)]$, &c., where $A = 0\cdot34\times10^{-8}$, $A' = 0\cdot8\times10^{-13}$, in/in/hr $\times 10^6$.

tropic at 350 deg. Cent., it was decided to investigate the effect of heating at 550 deg. Cent. by comparison on the basis of a test at 350 deg. Cent. with tensile stress 4½ tons per square inch, and torsion stress 3 tons per square inch, of a specimen subject only to the initial heat-treatment, and one heated *in vacuo* for 200 hours at 550 deg. Cent. Obviously, therefore, machining of the specimen wall had nothing to do with the anisotropy displayed.

In subsequent paragraphs emphasis is laid on the stress-strain relations characterising the isotropic behaviour of the steel over a considerable stress range at 350 deg. Cent. Attention is given additionally to the effect of anisotropy at 450 deg. Cent. and 550 deg. Cent., and at high stresses at 350 deg. Cent. on the characteristics of the steel.

(To be continued)

TABLE III—*Results of Pure Tension, Pure Torsion and Complex Stress Creep Tests on 0·17 per cent C Steel at 550 deg. Cent., Compared with Values Computed from Theoretical Considerations. All Values at 100 Hours*

Tensile stress, p, tons/sq in	Torsion stress, q, tons/sq in	Principal stress $\sigma_3=0$ throughout, tons/sq in: σ_1	σ_2	Octahedral shear stress, σ_0, tons/sq in	Axial creep rate, in/in/hr × 10^6	Circumferential creep rate, in/in/hr × 10^6	Axial creep rate corrected to mean curves, in/in/hr × 10^6	Circumferential creep rate corrected to mean curves, in/in/hr × 10^6	Principal creep rates (experimental), in/in/hr × 10^5: C_1	C_2	C_3	Octahedral shear creep rate (experimental N.P.L.), C_0, in/in/hr × 10^6
5·0	—	5·0	—	2·36	6·2(M)	—	—	—	6·2	— 3·1	— 3·1	8·8
4·0	—	4·0	—	1·89	2·1	—	2·2	—	2·2	— 1·1	— 1·1	3·1
3·0	—	3·0	—	1·41	1·4	—	1·25	—	1·25	— 0·63	— 0·63	1·77
2·0	—	2·0	—	0·94	0·5	—	0·53	—	0·53	— 0·27	— 0·27	0·75
1·5	—	1·5	—	0·71	0·33	—	$0·29_5$	—	$0·29_5$	— 0·15	— 0·15	0·42
—	3·3	3·3	—3·3	2·69	—	1·72(M)	—	—	8·6	— 8·6	0	14
—	2·68	2·68	—2·68	2·19	—	7·6	—	—	3·8	— 3·8	0	6·2
—	1·89	1·89	—1·89	1·54	—	1·85	—	1·6	0·93	— 0·93	0	1·52
—	1·09	1·09	—1·09	0·89	—	0·63	—	0·59	0·31	— 0·31	0	0·51
—	0·8	0·8	—0·8	0·65	—	0·52	—	0·41	0·21	— 0·21	0	0·33
1·27	3·15	3·85	—3·22	2·89	5·8	45	—	—	24·2	—21·7	— 2·5	37·7
0·98	2·44	2·98	—2·0	2·05	0·41	3·6	0·41	3·2	1·7	— 1·54	— 0·16	2·56
0·59	1·5	1·83	—1·24	1·26	0·16	1·35	0·19	1·48	0·79	— 0·71	— 0·076	1·23
0·39	0·97	1·18	—0·79	0·81	0·12	0·95	0·10	0·75	0·41	— 0·36	— 0·047	0·63
2·94	3·7	5·51	—2·57	3·37	45	160	—	—	99	—72	—27	145
1·96	2·44	3·62	—1·66	2·21	1·83	6·3	—	—	3·95	— 2·83	— 1·12	5·8
1·49	1·86	2·75	—1·27	1·68	0·60	2·2	0·60	2·1	1·35	— 0·95	— 0·4	1·96
0·97	1·20	1·78	—0·81	1·08	0·25	0·83	0·25	0·83	0·53	— $0·36_5$	— $0·16_5$	0·77
0·74	$0·93_5$	1·38	—$0·63_5$	0·84	0·14	0·46	0·14	0·49	0·31	— 0·22	— 0·086	0·45
4·48	3·0	5·99	—1·51	3·24	55	115(M)	—	—	84	—60	—24	122
3·03	2·0	4·03	—1·0	2·18	2·4	4·2	2·7	4·2	3·75	— 1·53	— 2·22	5·3
2·22	1·48	2·96	—0·74	1·6	1·65	1·85	1·48	2·24	2·04	— 0·76	— 1·28	2·92
1·43	0·94	1·89	—0·45	1·01	0·52	0·88	0·57	0·88	0·79	— 0·31	— 0·48	1·13
0·73	$0·47_5$	0·97	—$0·23_5$	0·52	0·13	0·4	0·15	0·32	0·23	— $0·17_5$	— 0·055	0·34

$$\sigma_0=1/3[\Sigma(\sigma_1-\sigma_2)^2]^{\frac{1}{2}} \qquad C_0=2/3[\Sigma(C_1-C_2)^2]^{\frac{1}{2}}.$$

TABLE IV—*Creep Under Complex Stress Systems of a Cast 0·17 per cent C Steel at 350 deg., 450 deg. and 550 deg. Cent. Results of Creep Tests at 350 deg. Cent. Under the Stress System $p=4·5$ Tons per Square Inch, $q=3$ Tons per Square Inch*

Condition of material	C_a, in/in/hr × 10^6	C_c, in/in/hr × 10^6	C_1, in/in/hr × 10^6	C_2, in/in/hr × 10^6	C_3, in/in/hr × 10^6	$=\frac{-\sigma_2}{(\sigma_1-\sigma_3)}$	$\frac{-C_3}{C_1}$
Initial heat-treatment only	0·089	0·178	0·134	−0·089	−0·045	0·2	0·335
Initial heat-treatment and week at 550 deg. Cent. *in vacuo*	0·12	0·10	0·145	0·02	−0·165	0·2	1·14

The results shown in Table IV indicate that while the unheated specimen gave a ratio $-C_3/C_1=0·34$ the specimen heated at 550 deg. Cent. gave the ratio $-C_3/C_1=1·4$. Evidently the heating at 550 deg. Cent. has in itself given rise to considerable anisotropy, and the extent of this anisotropy appears to depend upon the period spent at the temperature of 550 deg. Cent.

A few of the specimens concerned in the above consideration of anisotropy have been examined in the Metallurgy Division of the N.P.L. The metallurgical examination shows that changes in the ferrite-pearlite structure are occurring particularly at 550 deg. Cent. At this temperature the pearlite is slowly undergoing spheroidisation, and in some cases spheroidised carbide is beginning to disperse into the ferrite grains, and along grain boundaries. In certain tests where relatively high stresses have been employed, a finer set of grain boundaries has developed within existing ferrite grains[16]‡ (see Fig. 61 of paper referred to below).

It was suggested to the author that the high anisotropy occurring at 550 deg. Cent. was due to the effects of this temperature causing recrystallisation in the outer layers of the specimen walls after machining and lapping to size. To check this point a specimen was machined to size, then fully heat-treated *in vacuo* (being carefully examined for warping subsequently, no trace being observed), and then tested at 550 deg. Cent. (see base of Table III). The results of the test showed the same high degree of anisotropy as in previous tests, the ratio $-C_3/C_1$ being 1·37 as compared with previous 1·27.

‡ Bibliography will appear at end of concluding article.—Ed. THE E.

Nomenclature

Applied tensile stress	p
Applied torsion stress	q
Major principal stress	σ_1
Minor principal stress	σ_2
Secondary principal stress	$\sigma_3=0$ in all tests
Axial creep rate	C_a
Circumferential creep rate	C_c
Creep rate in direction of major principal stress	C_1
Creep rate in direction of minor principal stress	C_2
Creep rate in direction of secondary principal stress	C_3
Time	t
Angle between direction of major principal stress and axis of specimen	ϕ
Ratio q/p	a
Quantity $\sqrt{1+4a^2}$	b
Octahedral shear stress	σ_0
Octahedral shear creep rate	C_0
Principal strains	ε_1, ε_2, ε_3

Foundation Springs for Machinery

THE dynamic design of machine foundations was recently the subject of a paper read before the Institution of Mechanical Engineers.* The most important recent discovery in this field was said to be that the ground of any site has a natural frequency of its own, which is closely connected with the ultimate bearing pressure of the soil, and the ground and machine vibrations. An average natural frequency for soils is about 20 cycles per second.

Resonance troubles in machine foundations can be minimised by careful designing, and by the use of spring foundations. When correctly calculated, spring foundations can almost eliminate ground vibrations, and can thus reduce machine maintenance. We have received from the Andre Rubber Company, Ltd., Surbiton, Surrey, details of rubber springs which the company produces, about thirty spring constants in both compression and shear being available. These springs are claimed to be suitable for almost all machines and foundations, including the largest forging hammers. Furthermore, it is said that rubber is the most suitable material for this purpose, there being no risk of the rubber perishing if the design is good. Rubber will perish under the action of ultra-violet light, or due to contact with oil, both of which can be excluded; a third cause of deterioration is vibration fatigue, which apparently can be arranged not to take place for a number of years. The springs consist of sandwiches of vulcanised rubber between steel plates, the largest size being 56in by 8in, and capable of supporting 60 tons.

* "Dynamic Principles of Machine Foundations and Ground," by Hammond and Crockett, see THE ENGINEER, April 15th and 22nd.

Construction of the Castelo-do-Bode Dam, Portugal

No. II—(*Continued from page 115, July 29th*)

Cableway Excavators

SIX electrically driven cableway dragline excavators are being used to obtain aggregates from the river bed. Two of the machines have a maximum span of 820ft and four a maximum span of 660ft. Our drawing above shows the general arrangement of one of them.

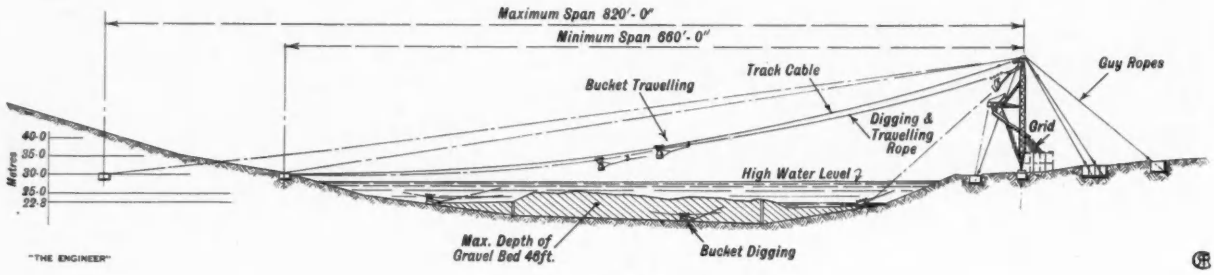
The excavator bucket is filled by being hauled a short distance over the gravel deposit by the digging and travelling rope, and when it is filled, the track cable is tightened by coiling in the hoisting rope to raise track cable, bucket and carriage. At the same time, the carriage and bucket are pulled forward by the travelling rope to the dumping point, where the bucket is tipped automatically into a hopper supported from the front of the head mast. The material is discharged down a steel chute into a hopper near ground level, from which it is loaded into Euclid trucks for transporting to the screening plant. The hopper at ground level is provided with a grid for removing larger stones.

Each excavator is equipped with a bucket having a capacity of 1½ cubic yards, and each machine can excavate and convey to the discharging point an average of 50 to 60 tons of material per hour, when operating over the average length of travel. However, the above capacity has been appreciably exceeded, as some of the drivers can complete an all-round cycle in 80 seconds.

The load carriage track wheels are fitted with ball bearings, and the buckets and chains are of very robust construction, as necessary for this sort of work. The front edges of the buckets are fitted with renewable hard steel teeth and cutting edges. The track cables are of locked coil construction.

The excavator winding gears are placed at one side of the respective head masts. There are two winch drums, each of 2ft 6in diameter, one for hoisting the track cable and the other for digging and conveying. These drums are driven from the motor through double helical first reduction gears, spur gear reductions and powerful friction clutches. The first reduction gears are enclosed in an oil-retaining case fitted with ball bearings. The friction clutches for travel, digging and hoisting, are engaged by automatic thrustors and released by weights. A foot lever brake is fitted to each drum.

The digging speed is 200ft per minute and the travelling-in speed 600ft per minute. The travelling-out speed 800ft to 1000ft per minute and the coiling speed at the drum when hoisting 200ft per minute. The motors are of the squirrel-cage type, with a continuous rating of 110 b.h.p. at 960 r.p.m., 380V, three-phase, 50 c/s, with oil-immersed star-delta starting. Hand winches and hauling rope are provided for altering the line of the excavators, by moving the track cable and adjusting the position of the rope strops at the tail end. Each dragline is controlled from a seat situated immediately behind the winch, from which position the operator has a full view of the digging, conveying and discharging of the bucket.



CABLEWAY EXCAVATOR

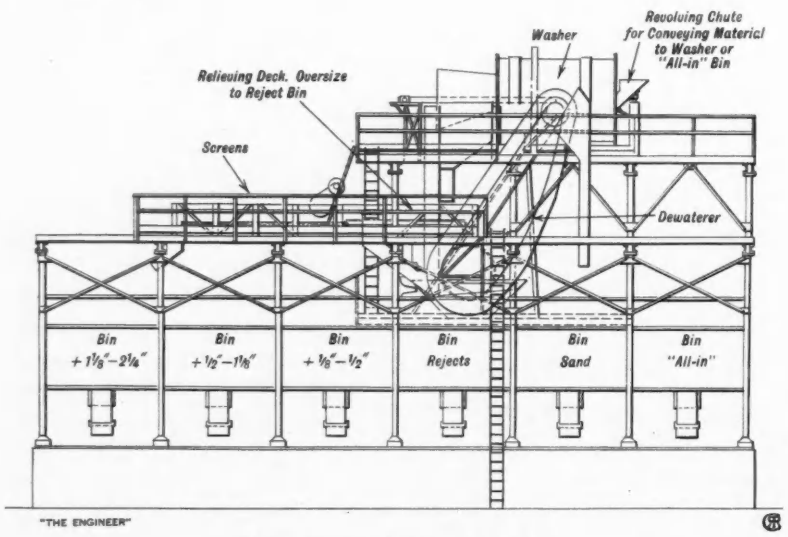
The excavators were designed, manufactured and erected by John M. Henderson and Co., Ltd., engineers, Aberdeen, and the electric motors and control gear were supplied by Metropolitan-Vickers Electrical Export Company, Ltd., Manchester.

Washing and Screening Plant

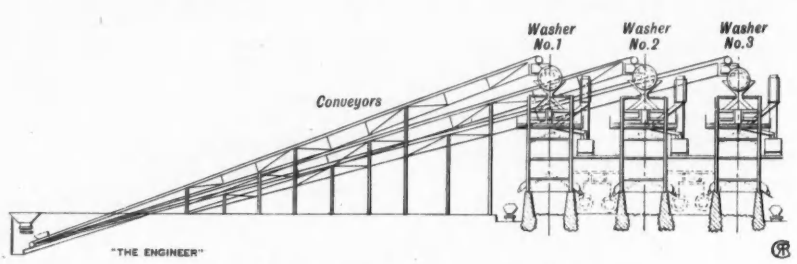
The sand and gravel washing and screening plant has a capacity of 300 tons per hour and comprises the various washing and screening machines linked together and built on to steel-frame storage bins. The plant is divided into three sections, each of which is capable of dealing with a total output of 100 tons of material per hour. The general arrangement of the plant may be seen from the two drawings reproduced herewith.

On arrival at the washing and screening plant the trucks loaded by the dragline excavators tip their load on to an 8in apertured grid over a feed hopper, the lip of which is placed just above ground level. There is one hopper for each section of the washing and screening plant; each hopper is capable of holding 10 tons of material.

The material is carried away from the hopper through an adjustable control door on a belt apron which runs at a constant speed. By this means the rate of feed to the main plant is maintained at a steady even flow. After passing through the control door the material is discharged on to an inclined belt conveyor, which elevates it to



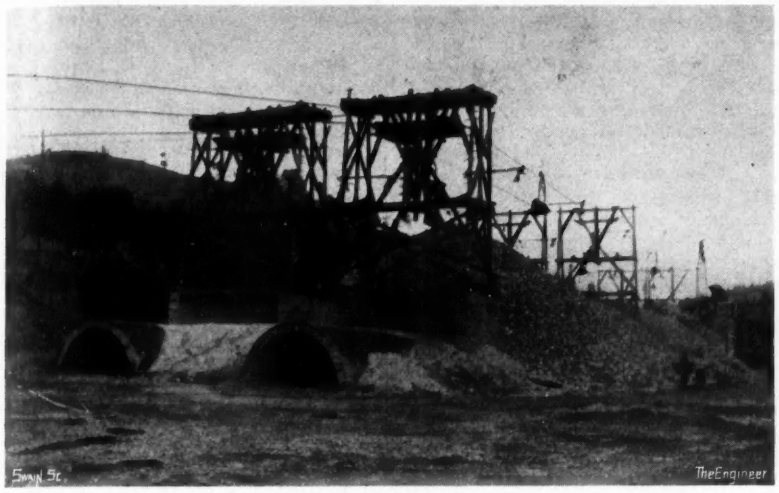
WASHING AND SCREENING PLANT



ARRANGEMENT OF WASHING AND SCREENING PLANT

the height required for feeding the washing plant.

This belt conveyor, which is motor driven, has a 30in wide rubber and canvas belt, carried and troughed by ball bearing idlers. The walkway which runs alongside the conveyor allows easy maintenance of the idlers and also provides one-way access to the platform around the washer.



STOCK PILES AND BI-CABLE ROPEWAY

At the head of the inclined belt conveyor the material is discharged through a chute into a rotating cylindrical washer which is 12ft long and 8ft in diameter. The water for washing is pumped up from the river and fed into the washer with the material. As the cylinder rotates the material and the water are continually churned by a series of short blades, which propel the material forward to the discharge end.

As the material and water are discharged they pass down a rotary screen attached to the washer in cantilever fashion, which separates the plus 4in size of gravel for storage in the bin below. The remaining material passes to two horizontal, oscillating screens, each 28ft long by 4ft wide, which separate it into plus 2½in to minus 4in, plus 1½in to minus 2½in, plus ½in to minus 1½in, plus ⅛in to minus ½in and fine aggregate passing ⅜in perforations. The largest grade (plus 2½in to minus 4in) is taken out at the feed end of the screen by a special top deck. The other grades are progressively separated as the material travels along the main screen deck, falling into the storage bins below.

The sand and water which has passed through the sand section of the screen (⅜in perforations), and which contains in suspension the dirt and foreign matter, is conveyed by chute to a "Sandor" dewaterer for further treatment. This machine comprises a tank with special baffles to aid the settlement of the sand, whilst the water containing the impurities flows away over a weir at a constant rate.

Perforated buckets are attached by legs to a 24in wide strong belt for dredging the sand from the tank. As the buckets rise the water drains away from the sand and returns to the tank. The clean dewatered sand is discharged from the buckets down a chute to a storage bin below the washer. The water containing the impurities flows away along the discharge trough back to the river.

The storage bins below the screens and washer have a total capacity of 1800 tons. Each bin section has a discharge outlet on both sides, one delivering to road trucks which carry the aggregate to the lower mixing plant for the building of the cofferdams and foundations, whilst the other outlet delivers to the buckets of the bi-cable ropeway system. The washing and screening plant was designed, manufactured and erected by Frederick Parker, Ltd., Leicester.

Aggregate Stocks

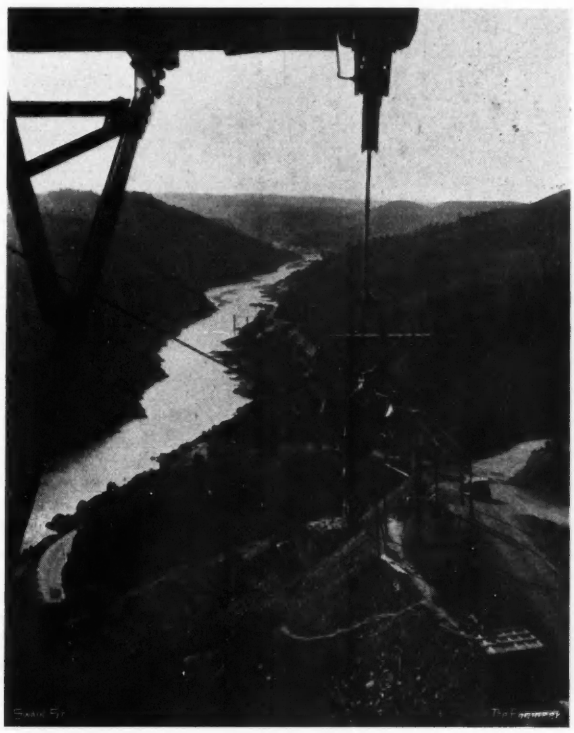
In the design and lay-out of the aggregate handling plant allowance had to be made for the provision of a considerable stock of aggregate owing to risk of interruption to the working of the dragline excavators by floods. Two alternative methods were considered: the first that the stock should consist of unscreened materials stored by the river with a small reserve of screened aggregate near the batching plant; the second that the entire stock should consist of screened aggregates stored near the screens. The first alternative entailed additional handling of materials in that a portion of the raw gravel would be stocked out and reclaimed, but gave a small reserve of screened aggregate at the batching plant. Both alternatives entailed stocking out and reclaiming of all screened aggregate. The second alternative was finally adopted, as it was considered that the likelihood of a breakdown of even one of the two ropeways leading from the screened stock piles direct to the batching plants was remote. Also, it was desired to make other use of the only suitable ground near the batching plants, which occupied a site near the dam.

Bi-Cable Ropeways

The two bi-cable ropeways, running side by side and parallel to the river, are used to transport the aggregates from the screening plant to the storage heaps. The three loading bunkers at the washing and screening plant are of steel construction and are each divided into compartments which receive the different grades of sand and gravel. Each ropeway is served by twelve chutes, the fines being delivered from overcutting type chutes and the coarser grades from undercutting chutes. Each ropeway is capable of transporting 200 tonnes an hour, though the equipment of one ropeway is designed for 150 tonnes an hour, and the other for 75 tonnes an hour. It is not necessary always to run both ropeways, for if the required capacity is not more than 200 tonnes, it may be carried on one ropeway alone. A shunt is arranged to transfer cars from one loading station to the other.

More than one grade of material may be carried at one time, as the buckets are arranged with long and short catches, corresponding to long and short trip bars suspended from the ropes at the storage heaps. Each bucket, as it is filled, is pushed by hand along the shunt rail into the locking frame, where it automatically grips the hauling rope, which pulls it up a gradient of 1 in 3·5 over the first trestle to the tipping ground.

In order to save steel and transport the three double trestles forming the intermediate supports for the ropes have been built of local timber, which is plentiful and of good quality. The fixing bolts and fittings were sent out from Britain, but the construction was carried out by Portuguese craftsmen.



MONOCABLE ROPEWAY

The tare weight of each carrier is 7·6 cwt

and the net load is 17·85 cwt (900kg), making a total of 25·45 cwt gross. The carriers are spaced at regular intervals along the line, which has an overall length of 720ft. The buckets pass automatically round the 16ft diameter end terminal sheaves, dispensing with the manual attention which would be required with a monocable type ropeway terminal. These sheaves are mounted on the 46ft high steel end stations.

The driving unit of each ropeway is powered by a 30 h.p. electric motor, running at 730 r.p.m. and reducing through vee belt drives and machine-cut gearing to drive the hauling rope at 360ft (110m) a minute from a sheave 5ft in diameter.

A bucket makes the complete circuit in four minutes and, returning to the loading station, it automatically unclips from the hauling rope and is carried by its own momentum along the shunt rail to the loading chute. As the carriages are fitted with ball-bearing wheels they require little driving effort and they are easily manipulated on the horizontal rail around the bunkers.

The 5¼in circumference locked coil track ropes are carried in cast iron saddles mounted on the trestles. At the loading station they are attached to spring gears, which indicate when they are tightened up to the fixed tension of 25 tons. They are anchored at the end return stations. The tension applied to the hauling rope, which is ½ ton only, is maintained by a weight attached to a tension sheave running on trolley wheels. The 2⅛in circumference Langs Lay hauling rope makes 2½ laps around the driving sheave. It normally has a slight sag between the carriages, to which it is attached at intervals of not less than 98ft, but when the line is stripped of its equipment it falls down into rollers mounted on the trestles at a level just clear of the passing buckets.

When there is a change in the grade of the material being dumped the trip levers at the various tipping points on the line can be put in or out of action by wires operated from levers situated at the loading station.

Conveyor Belts

Underneath the storage heaps there are belt conveyors running in reinforced concrete tunnels and following the lines of the ropeways. These tunnels can be seen in the illustration showing the bi-cable ropeway and the storage heaps. At the centre of each of the six storage heaps there are openings into the tunnel, covered by sliding gates. When material is required from one of the heaps the gate is opened and the material is delivered through a belt feeder on to the conveyor, which takes it to a large hopper constructed of timber and situated at the end station. This hopper can be seen in the background of the illustration. From this hopper the material is fed through six chutes into the buckets of the monocable ropeways. When sufficient of one grade of material has been delivered to the hopper the gate is closed and another gate opened, but time is allowed for the hopper to be emptied before another grade of sand or gravel coming along the conveyor reaches the hopper. One of the storage heaps is reserved for unscreened material, which can be delivered to it by trucks if there should be a temporary breakdown of the washing and screening plant. This material, having a proportion of sticky mud and having had little time to drain itself, is arranged to be fed on to the conveyors by special vibrating feeders. This is, of course, an emergency arrangement.

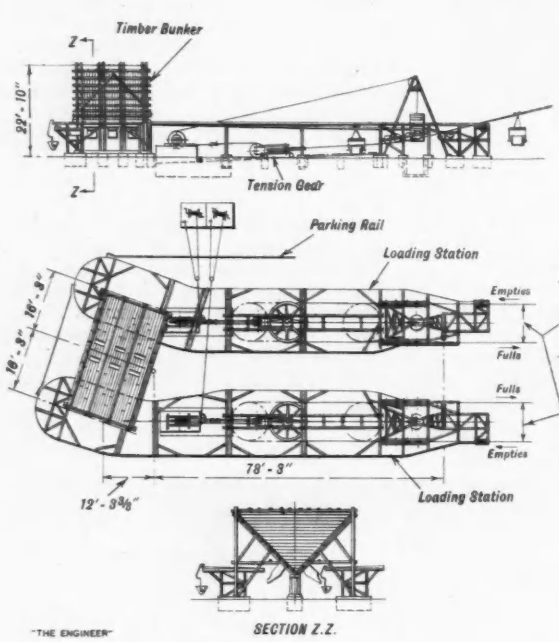
Monocable Ropeways

As the sand and gravel beds in the river are some distance from the dam site, it was necessary to find means of transporting the material from the storage ground to the two sets of storage bins incorporated in the main mixing station. A total capacity of 214 tonnes an hour was required, and it was decided to install twin monocable ropeways, each delivering to one of the two mixing station storage bins. This twin ropeway system conforms to the general plan of duplicating the equipment, so that if one set can deal with the capacity required, the other may be temporarily shut down. The monocable system was chosen on account of its low initial cost and because it was most suitable for the work of transporting the aggregate to the top of the mixing station. At this point it is hand tipped into any one of the compartments of the storage bins, which are circular in plan.

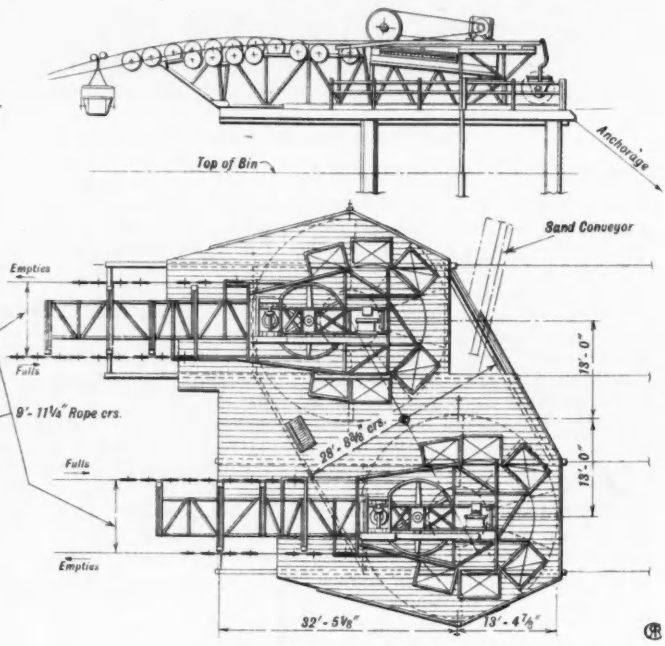
The length of each line is 1¼ miles (2070m) the speed of travel is 410ft (125m) a minute, and the individual loads are 700kg (13·8 cwt) net and 18·7 cwt gross. The main ropes, which serve the double purpose of supporting and hauling the carriers, are of 3¾in circumference Langs Lay construction. Each rope is spliced into one continuous length, passing around a tension sheave, 10ft in diameter at the loading end, and around a driving sheave of the same diameter at the unloading end. Intermediately it is supported on 25½in diameter line sheaves carried on twenty-five timber trestles varying in height from 15ft to 75ft. A view of the monocable, looking downstream from the top of the main mixing station, is illustrated on page 143. On the fulls side of each trestle four sheaves (in one case six sheaves) are mounted in balance beams, so arranged as to ensure that each sheave takes an equal share of the load. On the empties or return side beams with two sheaves only deal with the reduced loading.

Each ropeway is, as already mentioned, fed by three chutes from the timber hopper. The tension gear for the main ropes is situated at the loading end and the tension, applied by means of a suspended weight, is 9¼ tons. A long race is provided for the moving end sheave so that the difference in sag of loaded and unloaded ropes will not affect the amount of tension in the ropes. The unloading and driving stations are constructed in steel and are mounted over the main mixing stations so that bucket tipping can be effected direct from the ropeway shunt rails. The loading end of the monocable is illustrated on this page.

The load imposed by the ropeways on the structure of the mixing stations is very slight, as the track rope tensions are balanced by the tensions in the back anchorage ropes, which are carried down to the ground at the required angle of inclination. The 75 h.p. driving gears consist of three stages: first the belt drive from the 730 r.p.m. electric motor, then the bevel gear between the horizontal and vertical shafts, and finally the spur gearing between the vertical shafts and the rim of the driving sheave, to which a heavy machine-cut spur ring is bolted. As the loads are raised to a height of 350ft above the loading point, safeguards in the form of ratchet gears and brakes are provided to

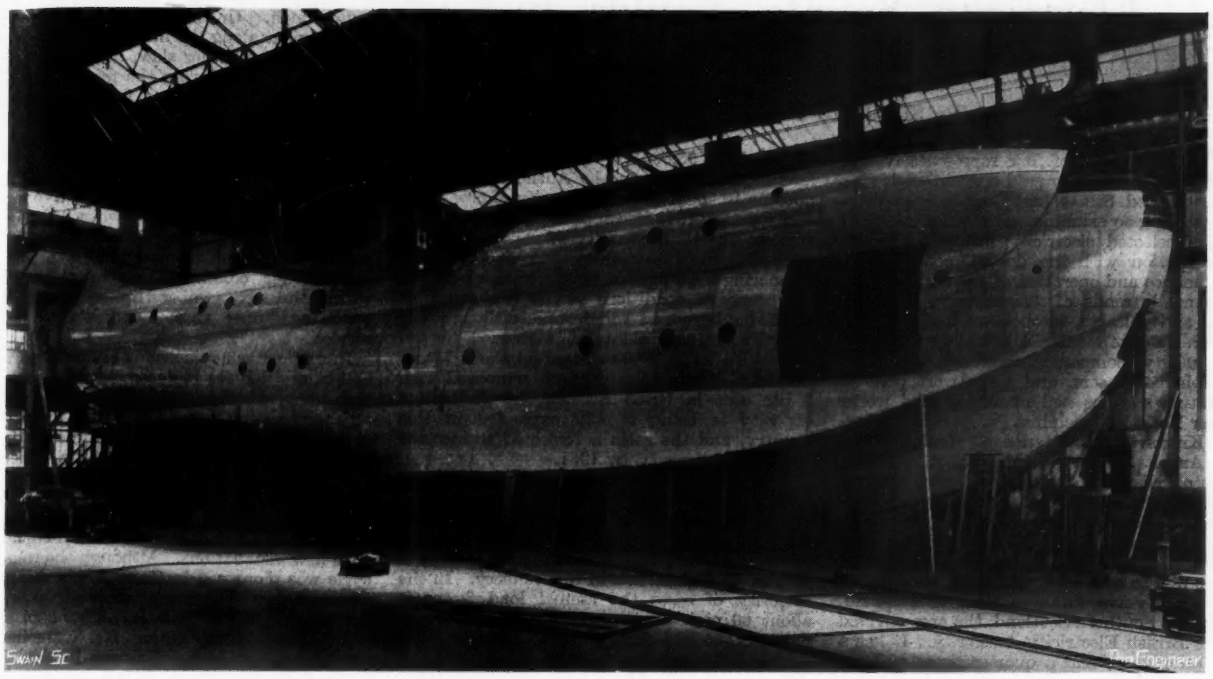


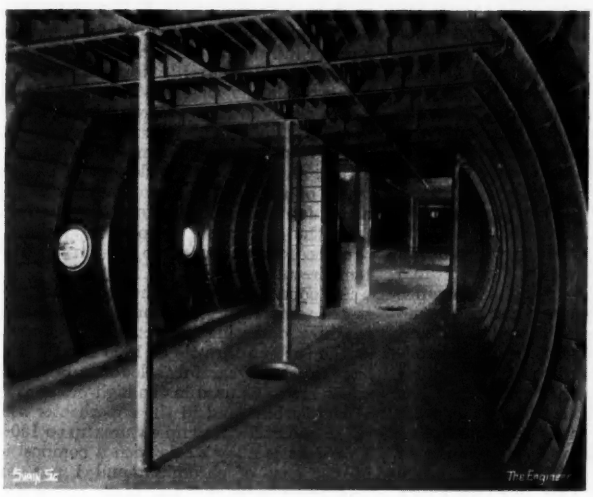
LOADING AND TENSION STATION



UNLOADING AND DRIVING STATION

HULL OF THE "PRINCESS" FLYING-BOAT NEARING COMPLETION





INTERIOR OF HULL—LOWER DECK

INTERIOR OF HULL—UPPER DECK

prevent a possible runback and to provide a speedy means of stopping the line. The arrangement at the mixer terminal of the ropeway is shown on the opposite page.

Between the two unloading stations is a shuttle conveyor, by means of which aggregate can be discharged from either ropeway into either storage bin in the main mixing station, thus enabling both mixing plants to continue in action, at any time when it is necessary to run only one ropeway. This shuttle conveyor is not shown in the drawings. The whole work on the dam depends on the ropeways keeping up the supply of aggregate, and every safeguard has been incorporated to ensure that nothing will occur to interrupt the work of construction.

Both bi-cable and monocable ropeways were designed and constructed by the British Ropeway Engineering Company, Ltd., of London, who also supplied the reclaiming conveyor under the stock pile and the shuttle conveyor on the batching plant. The electric motors and control gear were supplied by the English Electric Company, Ltd.

(To be continued)

Progress on the Saunders-Roe "Princess" Flying-Boat

ACCOMPANYING illustrations show that good progress is being made with the building of the three "Princess" Saunders-Roe aircraft at the makers' Cowes works. The hull of the first of the three machines was ready last week for withdrawal from its building stocks—a stage equivalent to launching in shipyard practice, prior to fitting out. The flying-boat, however, will not be fitted out afloat, large though it is.

The hull of the "Princess" flying-boat is said to be the largest metal structure ever built for an aircraft. As we have previously noted in these columns, it is built strongly, to resist the considerable stresses of alighting and taxiing on the water. It also has to resist a differential pressure of 8 lb per square inch when in flight, a pressure which amounts to 2900 tons spread over the whole of the pressurised section. Tests have been carried out to give a factor of safety of two with regard to water loading and pressurisation loads.

The three machines are being built to schedule the second and third machines following at intervals of four or five months.

Briefly, the "Princess" flying-boat is a ten-engined high-wing aircraft with single fin and rudder, designed to carry up to 105 passengers from London to New York at a cruising speed of 380 m.p.h. at an operating height of 40,000ft.

Its still air range is designed to be 5500 miles at full cruising speed. The power units will be Bristol "Proteus" III propeller-turbine engines, with a total of 35,000 h.p., eight of which will be coupled in pairs driving contra-rotating propellers, the remaining two being single units mounted in the outermost engine nacelles.

A figure for power to weight ratio of 9 lb per horse-power is given for the complete aircraft, which will have an all-up weight of about 140 tons. The performance therefore should be of a standard hitherto unknown with large aircraft, particularly as regards take-off and climb.

The aircraft will have a span of 219ft 6in, a length of 148ft, a height of 55ft 9in, and a beam of 16ft. 8in.

TURBINE LUBRICATION.—We have received from C. C. Wakefield and Co., Ltd., 46, Grosvenor Street, London, W.1, a booklet entitled "Turbine Lubrication." It contains fifty-six pages and numerous illustrations, describing the methods of lubrication used in various turbine systems, including notes on operating problems, hydrogen-cooled alternators and the gas turbine. Complimentary copies may be obtained from C. C. Wakefield, Ltd., at the above address.

Electricity Supply Trends in America*

By SIR JOHN HACKING†

A DELEGATION of four representatives of the B.E.A. recently paid a seven-week visit to the United States and Canada, the main objects being to examine and discuss the practices of selected electricity utility companies in connection with the design, construction, maintenance and operation of generating plant, the general trends of transmission developments and voltages, methods of load building and schedules of tariffs. Discussions were held with utility companies, manufacturers and consulting engineers, and visits were paid to generating stations and manufacturers' works at New York, Philadelphia, Pittsburgh, Barberton, Knoxsville, Chattanooga, Boulder City, Los Angeles, Chicago, Milwaukee, Detroit, Toronto, Niagara, Schenectady and Boston. A total of twenty-six steam and seven hydro-generating stations were visited, together with three sub-stations and seven manufacturers' works.

It is well to remember that the United States is some fifty-five times as large as England, Wales and Southern Scotland, the area covered by the British Electricity Authority. It has a population three and a quarter times as large as the population in this country, and many more natural fuel resources. Whereas coal and a little hydro power is the limit of this country's resources, the United States has coal, oil, natural gas and considerable water power.

The qualities of fuel in most areas of the United States are better than those normally available in this country. In the Eastern States calorific values of 13,000 to 13,500 B.Th.U. with ash contents of less than 10 per cent and moisture contents of 8 per cent are common. Special means are being adopted to burn the relatively poorer grade fuels by a number of companies. Owing to the exceptionally mild winter experienced this year on the East Coast, stocks of fuel oil have accumulated and there is in consequence a tendency for the price of fuel oil to fall. In many cases the burning of fuel oil instead of coal is more economical, and boilers have been adapted by the fitting of oil burners between the existing p.f. burners. On the West Coast, ample supplies of natural gas being available from oil wells, either gas or oil are extensively burnt.

The water catchment areas are much larger in the United States in relation to the population centres than in this country. The greater number of rivers and lakes provide ample cooling water and consequently there is very little need for cooling towers in the American stations.

The Organisation of Electricity Supply

The organisation of electricity supply in the States is on a company basis. The big electricity supply companies cover very wide areas, and many of them own several stations. They have quite close interconnection between the stations in their own area, but in addition there are very often interconnecting ties between the areas, and they do, on a voluntary basis, co-operate quite closely in regard to the pooling of their generating plants within the limits of the capacity of those ties. In general there are large sections of America which are coupled through the transmission system, and the maximum capacity so coupled is upwards of 20,000,000kW. It is not run as a close interlinked system. If one utility company wishes to get electricity from another, it is done by arrangement. Committees have been set up to help one utility company to buy from another, and to use the resources to the best advantage. The maximum demand of the public supply system in the United States during last winter approached 55,000MW compared with the maximum demand on the Authority's system of some 10,500MW. The capacity of new plant added during 1948 was approximately 4250MW, whereas the total capacity of new plant commissioned in this country was 566MW. In comparing these figures, the differences between the economic conditions in the two countries must be borne in mind, and although the capacity of new plant commissioned in the United States in 1948 represented about 7½ per cent of the maximum demand compared with 5 per cent in Great Britain, the productive capacity is being rapidly expanded in this country, and the ratio is expected to increase to about 11 per cent by 1951.

Load Characteristics

With regard to the load characteristics and load development policy of the supply companies, the load factor of the supply is in general very much higher than in this country. In the majority of cases the annual load factor is about 60 per cent compared with an average figure of 44 per cent in Great Britain. The seasonal demand factor—that is, the ratio of the average monthly maximum demands to the maximum demand in the year—was also considerably higher and in one or two instances the potential maximum demand varied little throughout the year.

These results are due to a number of factors. First, very little use is made in America of electric space heating and the tariffs of many of the companies are such as to discourage its development. Domestic and commercial buildings depend largely on some form of central heating either by steam, coal, oil or gas, and in consequence the electrical load on the system is less sensitive to temperature variations than in this country. Secondly, much wider use is made of air conditioning, which is responsible for quite a substantial load during the summer months. Thirdly, the average American home is well equipped with electrical appliances and the load factor of the domestic supply is reasonably high. Electric water heating is popular and the type of heater normally employed has a capacity of about 80 gallons with two-element control. The larger element is time controlled and is in service only between the hours of 10 p.m. and 6 a.m., but due to the large storage capacity of the heaters, this is sufficient to provide adequate supplies of hot water for all normal purposes. The second and smaller element enables additional supplies to be obtained at short notice if required, but this element is metered separately and a higher rate is charged. The use of these water heaters and the preferential tariffs which have been designed to encourage industrial load during the night have resulted in a substantial increase in the night load, which is normally something like 50 per cent of the daily peak load compared with 25 per cent in this country. The standard of general illumination, shop window lighting, display signs, &c., is higher than in this country, and this tends to increase the consumption of electricity during the evening.

Generating Plant Development

The thermal efficiencies achieved by some of the American stations are much higher than has so far been obtained in this country, the most efficient station being Port Washington at 32 per cent. The highest efficiency achieved by any station in Great Britain during 1948 was just under 27 per cent. Failure to achieve comparable efficiencies in this country are due to a number of factors, the greatest of which is the limited development possible since the beginning of the war. This has particularly applied to the development of higher steam pressures and temperatures.

Since the middle 1920s, certain of the American utility companies have experimented with high-pressure generating plant, operating at pressures between 1250 lb and 2400 lb per square inch. Until fairly recently, however, development along the lines of higher temperatures has been rather slow, and it is probably true to say that during the middle 1930s this country was at least as far ahead in such developments as the United States. Since shortly before the war, however, greater attention has been paid, in America, to the development of high-temperature installations, and a number of stations are now operating with steam temperatures between 950 deg. and 1050 deg. Fah. Although installations operating at temperatures up to 1050 deg. Fah. are planned for commissioning in this country within the next two or three years, no plant operating under these conditions is yet in service.

In stations where space is limited and where boilers are due for replacement, high-pressure, high-temperature sets, designed to feed straight into the existing low-pressure, low-temperature turbines are added. These are known as topping units and provide means by which the capacity of the station can be economically increased.

There is an increasing tendency in the United States to adopt reheating in connection with new installations. Although the reheating cycle was pioneered in Great Briain during the 1920s it has only been adopted to a very limited extent, owing to the higher capital cost and additional complication. Reheating installations have also been in service in the United States for many years, but here again no intensive development seems to have taken place until quite recently. Due to the rapid increase in the price of all forms of fuel, however, a number of the new installations employ the reheating cycle, the reheat temperature normally being the same as or little below the initial steam temperature. Where high reheat temperatures are used, difficulty may be experienced in controlling steam temperatures accurately, and with certain designs of boilers and types of fuel, it has been found necessary to recirculate a proportion of the gas discharge from the economiser or to adopt radiant type superheaters in order to obtain satisfactory temperature control.

In connection with the adoption of high steam temperatures, a number of installations are now operating with a steam temperature at the turbine throttle of 1050 deg. Fah. This has involved careful selection of materials which are to be used in the high-pressure stages of the turbine and in the superheater sections of the boilers. For temperatures up to 1000 deg. Fah. ferritic alloy steels with a composition of 2¼ per cent of chromium and 1 per cent of molybdenum have been used except for the last stages of the superheaters, where higher chromium content steels have been employed. For temperatures in excess of 1000 deg. Fah., special stabilised stainless steels, containing 18 per cent chromium and 8 per cent nickel, have been developed for the last stages of the superheaters and the valve gear and first stages of the expansion in the turbine. The use of these stainless steels has in itself created a further problem as, although stainless and ferritic steels can be welded, little experience of the reliability of such a welded joint under service conditions is available. A certain amount of apprehension is felt regarding these joints and in one case a mechanical joint is being developed as an alternative.

Hydrogen cooling of the alternators has been universally adopted on American machines. Although it is to be used in the standard 60-MW machines now being constructed in this country (Great Britain), none of these sets are yet in operation. The hydrogen pressure adopted in the older machines was about ½ lb per square inch, but a pressure of 15 lb per square inch, resulting in an increase in the alternator rating of about 15 per cent, is in common use on the latest sets. A number of machines now in course of manufacture are designed for a hydrogen pressure of 30 lb per square inch, which is expected to increase their rating by 25 per cent. The casings of the alternators are designed to withstand an explo-

* Lecture, British Electricity Authority's Summer School, Magdalen College, Oxford, July, 1949.

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sion pressure of 100 lb per square inch, and this margin is not increased with the higher hydrogen pressures, as it is argued that under these conditions there is less tendency for air to enter the machine. The only modification required in the design of the alternator is the fitting of an oil seal to withstand the higher pressure, and the cost of the machine is not increased appreciably.

Plant Availability

Under this head it should be mentioned that no specific periodical inspection of turbine plant is made each year and the tendency is to run the machines until there is a falling off in performance or evidence that some mechanical trouble is developing. An average rule is that the machines should be opened up for inspection every three years. With regard to boiler plant, insurance and state law requirements demand that each boiler should be examined once a year. This annual overhaul, even on large units, is normally completed within a period of ten days or less compared with the four or six weeks required in this country. Before a boiler is due for this overhaul it is examined internally by the operation and maintenance staff and a detailed schedule is drawn up listing the work which has to be done. All necessary materials and equipment are assembled on site before work is commenced, and a detailed programme and time-table is prepared. It is usual for two-shift working to be adopted in connection with routine maintenance, and a third shift is also employed if required in order to complete the programme within the scheduled time. A number of the utility companies visited owned and operated three or four separate stations, and it was their practice to have a number of maintenance men located at each station, together with a central gang which was transferred from station to station as required.

Minor repairs and maintenance are carried out during week-ends and it is probable that more extensive work can be undertaken on these occasions due to the fact that the five-day week is general throughout America and in consequence the period of low load extends from Friday night until Monday morning.

The better quality fuels generally available throughout the United States simplify many of the problems associated with the design of large-capacity, high-pressure boilers, and this in turn has resulted in the increasing adoption of unit boiler installations, with large machines. The use of a single boiler for each machine considerably reduces the capital cost of installation, as apart from the elimination of pipework, valves, &c., considerable saving in space, and consequently in building costs, is possible. At several stations visited machines of a capacity of 100MW were steamed from a single boiler. A second factor which has made possible the development of unit installation is the high availability achieved by boiler plant in America. This is primarily due to two factors, first, the use of better quality fuels, with in consequence less tendency to fouling of the main generator and superheater tubes, and secondly, the short period of outage which is normally required for the completion of overhaul on the boiler plant. Although there appears to be little prospect of obtaining an improvement in the qualities of coals delivered to generating stations in this country, we have in my view a good deal to learn from the Americans in the organisation and execution of maintenance work on boilers and generating plant.

Boiler Firing

In those stations which are coal fired, pulverised fuel is used almost exclusively, and although examples of retort and spreader stokers were seen, in no case were chain grate stokers employed. An interesting development was the application of the cyclone burner at the Calumet and Fisk Street stations of the Commonwealth Edison Company, Chicago. Experimental installations of the cyclone burner, both horizontal and vertical, have been in operation at the Calumet station for a number of years, and a large boiler has recently been put into commission at Fisk Street employing four such burners. Cyclone burners were seen under construction at the Barberton works of Babcock and Wilcox, Ltd., and appear to have several advantages for use in connection with poorer quality fuels. The range of fuels which can be burnt is wide, and it was stated that some 80 per cent of the solids normally present in the flue gas are extracted within the burner in the form of slag. This results in a cleaner boiler involving reduced maintenance.

Station Construction

The speed of erection of new plant in America was impressive; whereas in this country (Great Britain) the erection of a new boiler of medium capacity normally takes about eighteen months, large boilers were being erected in between eight and ten months. The time taken for the erection of large turbo-alternators was three months or less compared with the usual time of about nine months in this country. It is the general practice in America for these items of plant to be erected by the utility company's own staff under the supervision of one or two members of the manufacturer's staff. Adequate supplies of both labour and materials are available and in no case was the installation of plant being held up due to lack of components. Welding is widely employed in the assembly of boilers and pipework, and in one or two instances where several boilers were being installed, about eighty welding machines were seen on site. Another factor which materially assists the rapid erection of boiler plant is the installation at an early stage of the access ways, ladders, &c., which are normally installed with the main structural steelwork.

The relations between various classes of men and their employers appeared to be good, and there is the greatest co-operation to ensure that the work shall be completed by the required date. As in the case of maintenance work, two and sometimes three-shift working is common in connection with plant erection.

Transmission System

Although an experimental section of 500-kV line has been constructed for test purposes by the American Gas and Electric Company, it seems probable that the highest transmission voltage which will prove commercially economic will be 360kV. Lines operating at 220kV have been in service in the United States for many years, and the highest voltage line which was seen was the 287-kV line from Boulder dam to Los Angeles. Many of you will be aware that the B.E.A. are considering the construction of a 275-kV grid and that an experimental section of line operating at this voltage is now being built between Staythorpe and Sheffield. The extra high-voltage lines seen in America were invariably strung on single-circuit towers, and it was stated that the weight of steel required for two single-circuit lines was considerably less than for one double-circuit line.

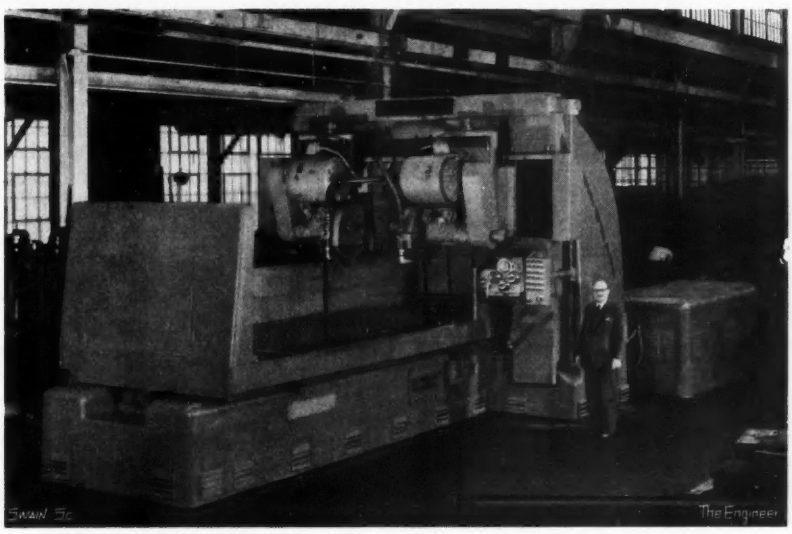
It is only possible in a talk of this nature to deal briefly with many of the developments which are taking place in the United States. Due to the intervention of the war and the need to concentrate on the manufacture of munitions, the development of power station technique in Great Britain was necessarily suspended for a time. Immediately after the war attention had to be given to the type of plant to be installed during the succeeding years, and it was thought prudent at that time to standardise on plant which, although representing an advance on previous practice, was likely to prove reliable and efficient in service.

It is now necessary to look a stage further ahead, and to clarify our ideas as to the types of plant which should be developed for installation during the next five to ten years. This visit to the United States has served a useful purpose in that we have been able to draw on American experience to help us in these matters.

A Large Surface Grinder

The photograph we reproduce below shows a new twin-head horizontal surface grinder, which has been installed at the Birmingham works of British Timken, Ltd., for use on railway axle housing production.

This machine, which was designed and constructed by the Thompson Grinder Company, of the United States, is claimed to be the largest of its kind yet built. It is about 35ft long, 16ft wide and 12ft high. The hydraulically operated table is powered by a 30 h.p. pump and motor and has a working area 10ft long by 6ft wide.



Large Surface Grinder

Work up to 8ft 4in wide can be admitted between the columns. Each of the two wheel heads is powered by a 30 h.p. motor and carries a 24in diameter, 5in wide periphery grinding wheel.

The machine has operating equipment of the most recent design, employing push button control, electronic timing control and solenoid-operated valves in the hydraulic system. Dual control is fitted and one operator can control all movements from each side of the machine.

A Large Curing Pan.—A curing pan weighing 58 tons, the largest ever made in Britain, has been installed in the Dunlop factory at Cambridge Street, Manchester. It was taken there by road from the makers, Foster, Yates and Thom, Ltd., Blackburn. The curing pan is 26ft 9in long; its inside diameter is 15ft, and the door alone weighs 13 tons. It will be used to vulcanise rubber products such as rubber-lined tanks.

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

STANDARDISATION OF PLAIN BEARINGS

RECENTLY we came across a peculiarly illuminating example of the need for just that kind of standardisation that, to judge by its interest in the affairs of the British Standards Institution, the Government would like to see brought about. There are, of course, many other examples that might as easily have caught our attention. But the one with which we are now concerned has the further advantage that it illustrates, also, how the well-directed efforts of an individual firm can begin to bring standardisation about. It is, no doubt, because plain bearings seem such simple devices that every firm has its own ideas as to how they should be designed. But the consequence is really astonishing. A single large firm manufacturing plain bearings in this country has, we recently learned, customers' separate individual drawings filed away to the number of no less than 20,000! It is hardly a surprise after reading that figure to learn that the firm concerned has given serious thought to the possibilities of standardisation, nationally, if not internationally, and to find that already it is playing a leading part in bringing about some degree of standardisation by agreement with its customers.

The firm which we have in mind makes ranges of bearings for the light and heavy engine building industry, for marine work and for a host of other applications in types ranging from plain bronze bushes to very large steel-backed white-metal or copper-bronze-lined bearings, thin-walled strip bearings for the automobile industry and wrapped bushes. The advantages to such a firm of making bearings in accordance with a standard list instead of to individual customer's designs are obvious enough. The manufacturer can make finished or partly finished bearings in bulk, can stock a wide range of sizes and can give immediate delivery at low cost "off the shelf." Nor are the advantages to the consumer any less readily seen. In many cases the design of bearings made by a specialist firm is likely to be in advance of the current practice of the smaller firms building engines or other mechanisms in small quantities, yet the standard part can be bought at a fraction of the cost of the frequently unnecessarily heavy bearing it can replace. In this way not only cost is saved, by reducing the bearing manufacturer's costs, but in the aggregate a very large quantity of raw material in the form of copper, tin and other metals can be saved. These considerations particularly apply where a thin-walled bearing can be used, perhaps in place of a very heavy steel and white-metal big-end, or of a direct-lined main bearing housing. It is notable that in such cases, where white-metal is reduced in thickness, there may be an actual increase in load-carrying capacity and life. In any case, whether the savings are in the form of pounds on large bearings or pence on bushes and small strip bearings, in the aggregate they are substantial, and they are reflected in "productivity" in all the senses urged by the present Government policy. Thus, the bearings are made in greater numbers at less cost; the saving extends to the maker of the mechanism in which the bearing is incorporated; it also extends to the spare part stores and servicing department; and finally the user gains. We mentioned in the first paragraph above that one company has some 20,000 customers' drawings. It is interesting to learn that a firm holding a very similar position in the United States of America can make its bearings in a range from five to ten times less in number of types than can the British company, and as a result has an output perhaps double that of the British firm. Yet in all other ways, such as technique of manufacture and brains of the management, no invidious comparisons can be drawn! The greater output per man-hour can be entirely ascribed to long production runs using expensive press tools, and to lower overhead and management charges, owing to the very considerably smaller number of different bearings to be made.

The programme which the British company has initiated is as yet not complete. It has been two and a half years in formation, and, as described on another page of this issue, its first stages have met with considerable success. Starting with standard wrapped bushes and a series of standard thin-walled bi-metal half bearings in sizes up to 4in bore, it is reported that within eighteen months each size within that range was taken up by at least one engine manufacturer. Now a further stage is announced, in that an attempt is being made to standardise half-bearings for larger engines, in sizes from 4in to 10in. The design of tooling is nearly completed and a questionnaire has been circulated to engine building firms to seek their views on the possibilities of thin-walled bearings in these sizes. Yet a further stage in the firm's programme is the projected standardisation of the "common or garden" cast phosphor-bronze solid bush, which still has applications in such machinery as concrete mixers and agricultural implements, where abrasive wear is heavy and thin wrapped bushes would be out of place. It is interesting to learn that the company's standards, though not convertible to round metric sizes, have already been adopted by the French Bureau of Standards, and Sweden has shown interest in the matter. In all its programmes we understand the company has a strong desire to reach common standards with other manufacturers, and ultimately to produce a range acceptable for a British Standard.

THE GOVERNMENT AND THE IRON AND STEEL BILL

THE long expected and apparently predestined conflict of opinion between the House of Commons and the House of Lords about the Iron and Steel Bill occurred last week, just before Parliament adjourned for the summer recess. The Commons refused to accept a number of amendments carried against the Government in the Upper House. The Lords reluctantly agreed to the deletion of all those amendments save only those relating to certain dates. They insisted that the Act should not come into force until October next year and that vesting day should be deferred from May, 1950, to July, 1951. In effect all that prevents the Bill rapidly passing into law is a conflict between the two Houses as to whether the Act shall become effective before or after the forthcoming general election.

The ways of politicians are often enigmatic to straightforward practical people like engineers. No doubt to politicians the situation seems clear enough. No doubt they can find reason in this quarrel. But for ourselves we confess that we are puzzled. For why does the Government insist upon the immediate enforcement of the Act and the retention of a vesting date next May? Socialists, of course, are in a hurry to see what they regard as an urgent measure on the Statute Book. Nor can anyone misunderstand the desire of the Government to make the Bill law before the coming general election is held. For should it not have received the King's Assent before the election, and should the Socialists be again returned to power, a new Bill would have to be passed through all its stages in both Houses of the new Parliament with consequent delay and repetition of effort. But the passing of a controversial Act and the enforcement of it just before a general election in which the people inevitably will express approval or disapproval of it are two wholly differing things; and, surely, the fact that the election may bring into power a party bitterly opposed to the measure must necessarily make mischievous any attempt to enforce the Act before that election is held. Continued insistence by the Government upon the retention of a day next May as vesting day can, then, only prove harmful to the interests of the iron and steel industry and of the country as a whole, in that it must arouse uneasy speculations as to the intentions of the Government. It is certain that the Government, by invoking the Parliament Act, can force the Bill through. But will it

really attempt, in the short time that will be left to it after the Bill has become an Act, to set up the proposed Iron and Steel Corporation and to take over the assets of the many firms affected? Does it really hope to face a Conservative administration, should the election favour that party, with the *fait accompli* of an industry already nationalised? We confess that we find it difficult to believe that any political party could be quite so irresponsible as to make the attempt. Moreover, even if the attempt were made, what hope has the Government of finding eminent men with experience of the industry willing to sit upon the Corporation? Even if the electorate returns it to power, the Socialist Government is not going to find easily men of experience to serve upon a Corporation, the creation of which they bitterly opposed. Who amongst them will agree to serve upon a detested Corporation liable to become defunct in a matter of a few weeks after its creation?

The Government claims that it has a mandate from the electorate to nationalise the iron and steel industry and that by their opposition to certain clauses in the Bill the Lords are flouting the people's expressed will. Politicians, we feel, may be left to argue about the merits of those points. We, as practical engineers, are concerned only with facts; and to us it appears that, in fact, the fate of the iron and steel industry will not be settled by the insertion of this date or that in the Bill before Parliament, but by the decision of the people of this country at the coming general election. Thus, whether or not the Government had its mandate, we find it surprising that the situation is not accepted for what it is; and that the Government does not either accept the Lords' amendments (which do not affect the Bill in principle), or alternatively announce at once the postponement of enforcement of the Act until after the election. The adoption of one of those courses seems to us not only reasonable, but eventually almost inevitable. But no doubt, being plain practical engineers, we just do not understand these things.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

LOCOMOTIVE INTERCHANGE TRIALS

SIR,—The results of the 1948 inter-regional locomotive trials provide fascinating reading.

The Western Region disappointment seems largely to be confined to the "Hall" class, which on its own ground has a reputation for fast running. The consistent performances of the Eastern Region "A 4" "Pacific" raise the question, "Did streamlining influence the result?" At first sight streamlining appears to have no effect either way, as the "Merchant Navy" and "West Country" locomotives consumed so much more coal than the "A 4." But the Southern Region engines, officially described as "air-smoothed," do not possess the smooth, rounded nose of the Gresley "Pacific," and in streamlining a suitable shape of nose is as important as smooth sides.

It would be instructive to see the modern "A 1" "Pacific," designed by Mr. Peppercorn for the Eastern Region, tested over the same routes as the Gresley engine in the 1948 trials. We should learn whether the latest non-streamlined product of Doncaster used more coal than the earlier engine, and whether the modifications in mechanical design have overcome the defects which led to failures with the "A 4" on the Western and Southern roads. Removal of the "air-smoothing" from a "Merchant Navy" and a "West Country" is another experiment which might profitably be made to ascertain how much, if at all, fuel consumption and performance were influenced by the outer casing.

The "West Country" "Pacifics" have naturally shown a marked superiority in performance over their 4–6–0 competitors, and this poses the question, Are so many 4–6–0 mixed traffic engines really necessary? The London Midland "Class 5" is restricted in size by certain curves on the former Midland system, and the Eastern Region "B 1" by engineering restrictions on the former Great Eastern Railway. Surely a better policy would be to build larger engines for mixed traffic work on all but the restricted routes. How often does one hear of an important main line express experiencing delay due to a train ahead pulled by a mixed traffic 4–6–0 failing to keep time? Often one sees a "B 1" hauling a suburban rake which a 4–4–0 could handle with ease. The modern mixed traffic 4–6–0 is an engine which is very frequently under or overworked.

The suggestion is made that the L.M.S. Railway found twelve types of locomotive sufficient for the whole of their system, and that twelve classes therefore are all that British Railways will require. But was the L.M.S. policy really successful? Many delays on the Carlisle to London line could have been averted or eased considerably had they possessed a large mixed traffic 2–6–2 or 4–6–2 with 6ft or 6ft 2in driving wheels, instead of relying so much on "Class 5" 4–6–0 engines. On the Highland line larger engines might have avoided much double-heading.

Mr. Holcroft's timely letter on the subject of coal supply has shown some of the pitfalls which face an attempt to produce standard locomotives for all Britain. We may yet discover that variations in construction are necessary before engines will produce their best work on varying fuels. Although we all hope for touches of genius worthy of Churchward and Chapelon, the construction by each Region of its own types, improved as the result of systematic interchange trials and Rugby tests, may prove most profitable in the long run.

F. A. S. BROWN

Alexandra Grove, N.4,
July 29th.

North-East Coast Steel Works Expansion

DORMAN, LONG AND CO., Ltd., has announced that the second stage of its major development plan is to be put in hand immediately, involving a further capital expenditure of over £8,000,000. This second stage includes the building of an open-hearth steel plant at Lackenby, with a capacity of 10,000 tons of ingots per week; the extension of the new ore-grading plant at the Cleveland works, and the installation of new blast-furnace ancillary equipment. It is anticipated that all the work can be completed by September, 1952. It will be recalled that the first stage of the company's development programme was the installation of central ore-unloading equipment and ore-preparation plant at the Cleveland works, together with a private railway line over 3 miles in length across the Lackenby site, and linking the Cleveland and Redcar works. These two projects, costing nearly £2,250,000, are now in operation. The design of the ore-preparation plant made provision for extending its capacity, and it has now been decided to undertake the extension and increase the tonnage of prepared ores in order to make supplies available to more blast-furnaces.

The major development plan includes new blast-furnaces at the Cleveland works, and the installation of ancillary blast-furnace equipment at these works will fit into the blast-furnace building programme. Simultaneously with the carrying out of the first stage of the development plan, extensive preparation of the site of the Lackenby works, covering 650 acres, has been virtually completed. The company says that it is now possible, therefore, to proceed without delay with the actual work of constructing the new open-hearth steel plant. The construction work now to begin is part of the national development plan for the steel industry approved by the Government, and is in line with the movement towards greater concentration of North-East Coast steel production. The national plan includes installation in the Lackenby area of extensive steel rolling mill equipment, as circumstances permit.

Atomic Energy Progress in America

ON Monday last, August 1st, the sixth half-yearly report of the United States Atomic Energy Commission was submitted to Congress. The report indicates that atomic energy development is progressing satisfactorily, and that during the first six months of the year, covered by the present report, the pace of the advance has been quickened. In the section of the report dealing with military uses of atomic energy, it is stated that new and more effective atomic weapons than those which were tested last year have been designed and are in production. Under the direction of the Commission the components of these weapons are now being produced on a commercial basis by manufacturing concerns and in special Government factories throughout the United States. There seems no lack, according to the report, of the supplies of fissionable material, such as the uranium 235, which is needed for atomic weapons, and for other nuclear reactors. In the period under review, steps have been taken to improve and render more certain the supplies of uranium ores, both from abroad and from home sources. A careful survey of all possible sources of supply in the United States has, it is stated, revealed the presence of abundant supplies of low-grade uranium ores. These materials, although more costly to process, would nevertheless sustain America's atomic energy military programme, even if the supply of high-grade, low-cost uranium ore was to be cut off. The report also contains, we understand, a detailed analysis of the effect of the atomic bombs which were dropped at Hiroshima and Nagasaki, and also the test bombs at Bikini and at Alamogordo, in the New Mexican desert.

Technological Studies in America for British Students

IT is announced by the Economic Co-operation Administration that it will give assistance in arranging to send up to fifty scientists and technologists from Great Britain to America for graduate study in leading technical colleges, followed by training in production methods in American factories. The project, it is stated, has already been approved for a one-year course, and later on it may be extended to embrace a two years' training course. This scheme, it is pointed out, is part of the technical assistance programme of the Economic Co-operation Administration, which is directed towards increasing the industrial production and industrial efficiency of European countries. After completing their training in America the chosen scientists and technologists will go directly into British industrial enterprises, into industry overseas, or will teach in newly expanded university departments of technology. Those who accept university posts will be available for consultation by industry. The United Kingdom Government will, it is understood, pay the sterling expenses, including the Atlantic transport charges. The assistance to be granted by the Economic Co-operation Administration will, it is expected, amount to about 3000 dollars a year for each individual, which will provide for maintenance, tuition, and travel in the United States of America, and will also cover the cost of books, and other expenses.

ABBEYDALE WORKS, SHEFFIELD

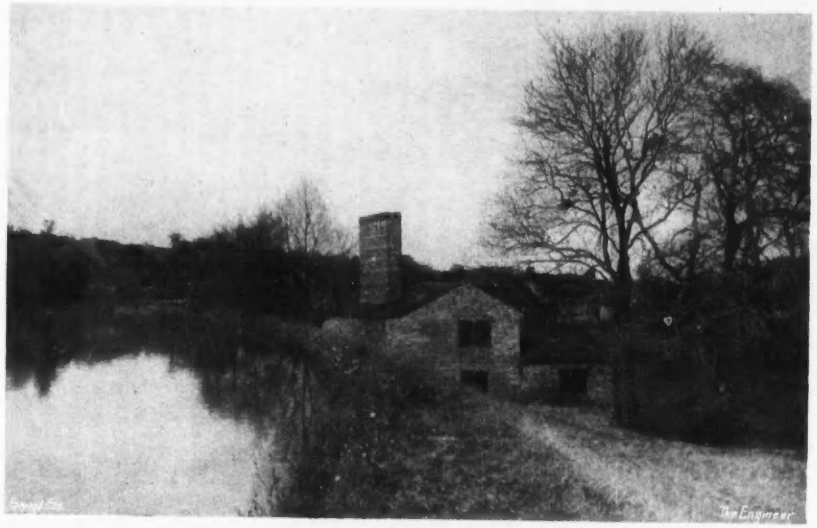


FIG. 1—ABBEYDALE WORKS

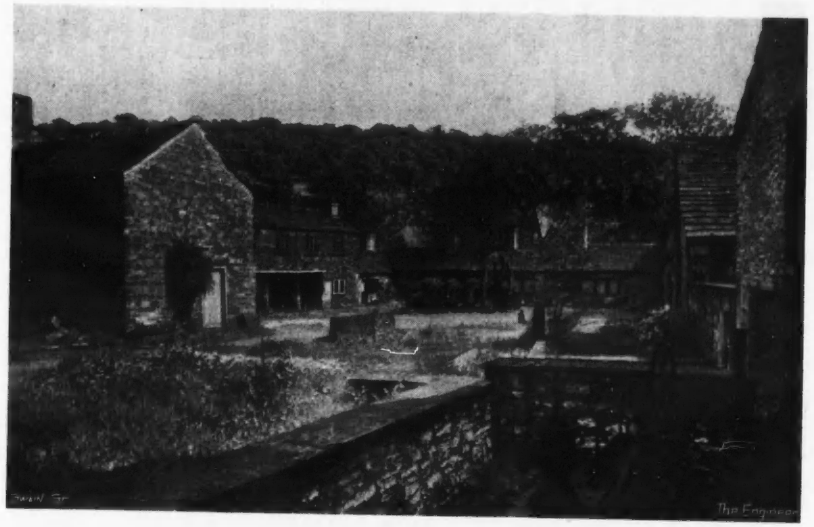


FIG. 2—MILL YARD, ABBEYDALE WORKS

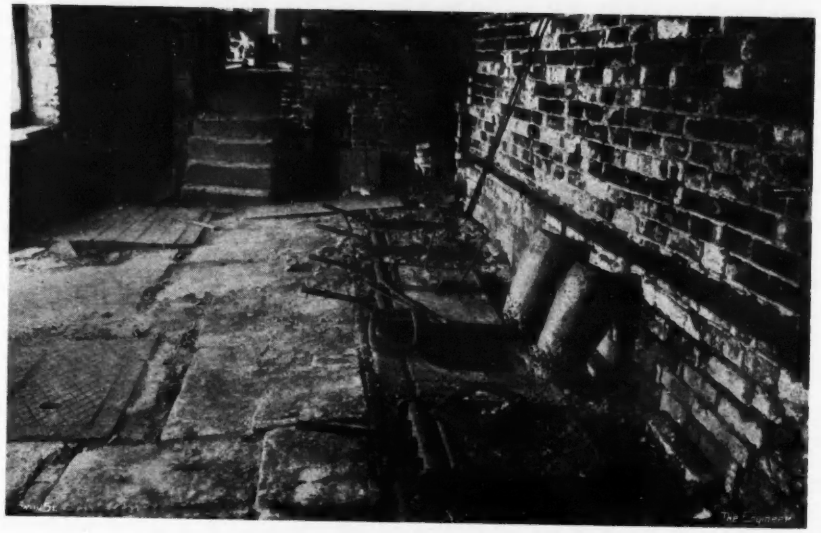


FIG. 3—CRUCIBLE STEEL MELTING SHOP

FIG. 4—TILT HAMMER IN SCYTHE FORGING SHOP

Abbeydale, Sheffield

ON a recent visit to Sheffield we were privileged to be taken by a member of the Sheffield Trades Historical Society to Abbeydale Works, about which and its potentialities we had heard a great deal. The works are situated in the valley of the Sheaf (from which the City takes its name), one of the tributaries of the River Don, some 3½ miles to the south-west, and actually now a suburb, of Sheffield. The very name is attractive and suggestive for it is derived from the fact that in the Middle Ages the valley was part of the demesne of the Abbey of Beauchief, of the Premonstratensian Order, known in this country as the White Canons. The Abbey was founded in 1183 by Robert Fitz Ranulph de Alfreton, Lord of Norton, in what, at that date, was undoubtedly a sequestered spot, such as the Monks of that Order always chose. Even to-day, the area has not entirely lost its former beauty.

At what date water power was first used in the valleys of the Don we do not know. The earliest record we have is that of a corn mill built on the Blackburn brook, 2 miles north of the City, in A.D. 1141, by the Monks of Ecclesfield Priory. In A.D. 1280, Sir Ralph de Eccleshall gave to Beauchief Abbey his corn mill on the Sheaf at the place which is now known from that fact as Millhouses; this dam and mill remained use in

FIG. 5—WATERWHEEL FOR DRIVING TILT HAMMERS

for upwards of six centuries. Ultimately, the Abbey possessed five mills and a forge; Abbeydale Works is on the site of one of these mills.

As time went on Sheffield expanded as a manufacturing centre, largely because of the available water power, for the height above sea-level is here about 500ft. The Sheaf was, in common with other tributaries of the Don, pressed into service by dams across the streams and employed, as described by Justice Sir Anthony Fitzherbert in his "Boke of surveyinge and of improvements," (1523) thus: "It is to be understande, that ther be many maner of mylnes as cornemylnes, windmylnes, horsemylnes, and quernes that goo with hande. Fullyingmylnes, sythemylnes, cutlersmylnes, smethymylnes and all suche other as the whele gothe by drifte of water to blowe the bals or to draw any water lyke a pompe, as there be in Cornwall and dyvers other places." Not only so, but in course of time water power was employed for the heavier duties of forging and slitting of iron and, after Huntsman's invention of crucible steel in 1742, the forging of steel, by means of tilt hammers; in fact, it was upon this abundance of water power as well as the presence of raw materials for iron making that the industry of Sheffield has been built. Miller* has adduced evidence of the existence, during the historical period, of 144 dams in the area between Oughtibridge in the north and Tinsley in the south, and each of these dams might have served more than one "wheel." There is no other area in Great Britain where water power has seen such extended use as here.

Nothing is known of the origin and but little of the history of Abbeydale Works, as is the case with nearly all the other works in the valleys. On the earliest plan that we have seen, prepared in 1780, Abbeydale is marked simply as a "wheel," but we assume that the works had been going long before this. The works with the dam are now included in the estate which constitutes Abbeydale Park, bought and presented to the Corporation of Sheffield by the J. G. Graves's Trust. A general view of the dam and building is given in Fig. 1, and a view of the millyard in Fig. 2. The date-stone on the existing building housing the tilt hammer is 1785; the grinding shop was built by M(ichael) G(oddard) in 1817. In 1852, William Tyzack and his successors, William Tyzack and Sons, under lease from Earl Fitzwilliam, began their long connection with the works. Like their predecessors, they were scythe and hay-knife makers, so that the works have specialised in this trade for from 130-140 years.

It is true that there is no furnace for converting of iron into blister steel, but there is a shop with a range of six crucible steel melting coke-fired furnaces for casting ingots (see Fig. 3). The wooden floor where the local ganister clay was trodden underfoot to the right consistency for crucible making,

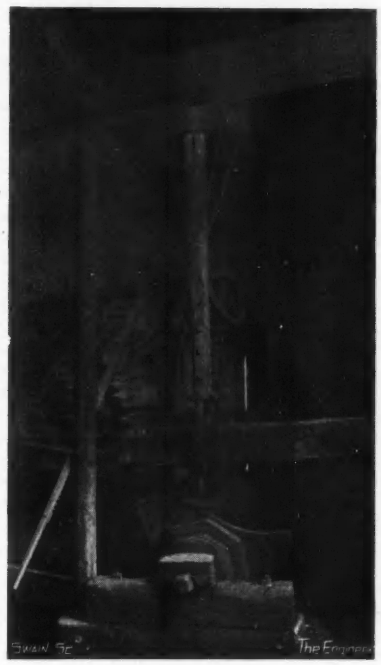


FIG. 7—CAM-DRIVEN BLOWING CYLINDERS

is in evidence, as are also some of the crucibles, used and unused, and the shelves upon which they were stored to season. This shop was used as recently as during World War II.

The principal work performed at Abbeydale was, as we have said, scythe forging, and for this the traditional tilt hammers, in the shop dated 1785, were used (see Fig. 4). It is perhaps not supererogatory to explain, for the benefit of the present generation, that a tilt hammer is really an ordinary hammer enlarged in size and mechanised. Three varieties can be distinguished: when the helve, i.e., the hammer shaft, is pivoted near its middle and depressed by cams on a

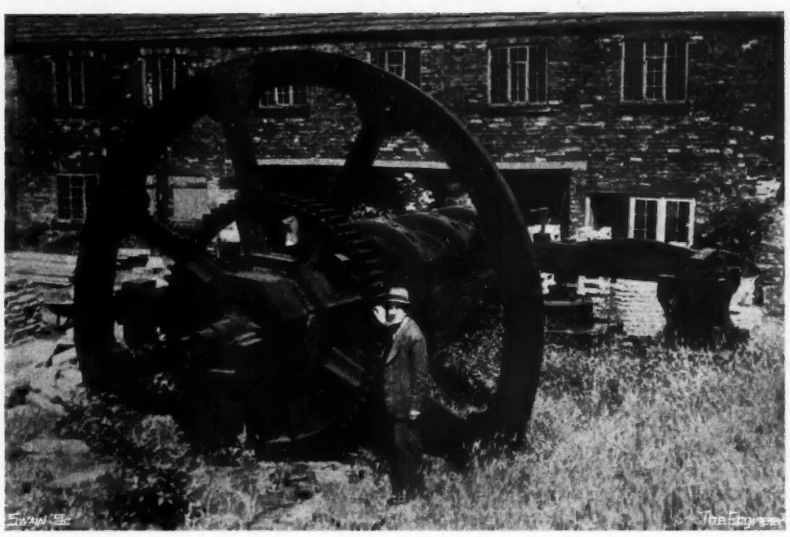


FIG. 6—JESSOPP'S TILT HAMMERS IN MILL YARD

* Miller, W. T., "History of the Sheffield Water Mills," 1936.

ring on the end of the shaft remote from the hammer head, it is known as a tail helve; when the helve is pivoted at its end and raised by a similar cam ring under its middle, it is known as a belly helve; when the helve is pivoted at the end remote from the hammer head and raised by a projection at the head by a cam ring, it is known as a front or nose helve. Normally the working speed is about eighty blows per minute. This can be adjusted by admitting more or less water to the waterwheel, which is done by adjusting the sluice from the mill dam; the long lever for doing this is shown prominently in Fig. 3. The stroke is, of course, invariable, and this means that an anvil is crowded when the forging is of large dimensions. Two expedients were adopted to overcome this; the anvil could be lowered or a spring beam could be applied over the helve. A 10 o'clock waterwheel, 18ft dia. by 5ft 8in wide (see Fig. 5), actuated the camshaft, which is octagonal in section, 3ft across the flats, made out of a single oak tree, dimensions that seem to be almost unprocurable nowadays. The gearing between the wheel and the camshaft, 3 : 1, is of timber of clasp arm construction with wooden cogs, and there is a fly-wheel 13ft dia. by 8in wide to store energy. The outer end of the shaft drives cropping shears, which are simply enlarged scissors, whose arms are in the ratio of about 8 to 1. The blast for the hearths was supplied by a narrow waterwheel, 15ft dia. by 22in wide, driving by two three-throw cam rings, two vertical shafts (see Fig. 7) attached to pistons of blowing cylinders 2ft 4in dia. These shafts are steadied and restrained by horizontal beams pivoted at a point some distance through the wall seen on the right; this gives the piston rods a motion that deviates but slightly from a straight line. The whole is an intriguing example of 19th century millwrighting.

On the far side of the yard are six hearths for individual craftsmen, each with its own bellows. These hearths are of the same character as those in Sheffield "tenement" forges, but are larger, naturally, because they are for forging hay-knives and the smaller-sized scythes.

Next door to the forge is the grinding shop, dated 1817. Here there have been four "trows" or troughs for grindstones, driven through shafting and bevel gearing by a 10 o'clock waterwheel, 18ft dia. by 6ft wide, all of similar construction to the plant already mentioned. Also in this shop there has been provision for three smaller trows driven by belting from the bevel shaft. At a comparatively recent date, the water power, owing to the demands upon it, had evidently proved insufficient, perhaps during the summer season when the river is at its lowest, for a horizontal steam engine, 12in dia. by 2ft stroke, has been installed out of doors to help out the drive. The boiler has been scrapped, and the chimney stack has been felled because it was judged to be in a dangerous state, but the boiler seating remains. On the premises are any number of grindstones that have been discarded when worn down to about 14in dia.; indeed, so numerous are they that a building in the millyard has two piers, each composed of a pile of these worn out stones, and some are built into the bank of the mill dam. On the side of the yard, opposite to the forging shop, there is a warehouse where finished articles were stored, and also a counting house. In the gatehouse of the yard there is a platform weighing machine, the lever of which is connected by a rod to a beam on which is a sliding weight marked "George Sal . . . ter Sheffield." It would be interesting to establish the date of this curious link in the development of the weighing machine.

This is not all. The Historical Society has been allowed by the Sheffield Corporation to bring together here some old plant from outside sources. In the yard there is a noble stand of two tail-helve hammers and a front helve, with the gearing involved, removed from the works of William Jessop and Sons, Ltd., of date about the second decade of the 19th century (see Fig. 6); every detail of this is of extreme interest. In the grinding shop, an Oliver, a kind of mechanical hammer still used in the nail making trade as well as in cutlery forging, has been introduced. It consists of a hammer of sledge-hammer weight hinged in a wooden frame, and this is brought down on its anvil by a foot lever, returned by a spring pole overhead. The origin of this useful tool, which is the equivalent of a smith's striker and the derivation of the name are both equally obscure.

Another exhibit of great interest is a stand of rolls, 6in dia., for merchant iron; it came from Old Wortley Ironworks, where it is said to have been installed in 1795 by James Cockshutt, a contemporary of Henry Cort; the statement that this was one of the first rolling mills ever seen in Sheffield is quite credible.

The disappearance of the old mills of Sheffield, as far as concerns their industrial use, is inevitable for economic and other reasons, but we should like to see one of them at least retained in working order for the instruction and interest of generations yet to come. Abbeydale seems to be cast for this role, and we are pleased to learn that it has been decided to preserve the buildings; we trust that it will be found possible also to retain the plant in them as it stands. The whole scene—the dam, the machinery, the substantial masonry buildings enclosing the millyard, together with a row of workmen's cottages, constitute a typical representation of a plant for the manufacture of Sheffield products of the early part of the 19th century, such as is nowhere else now to be found.

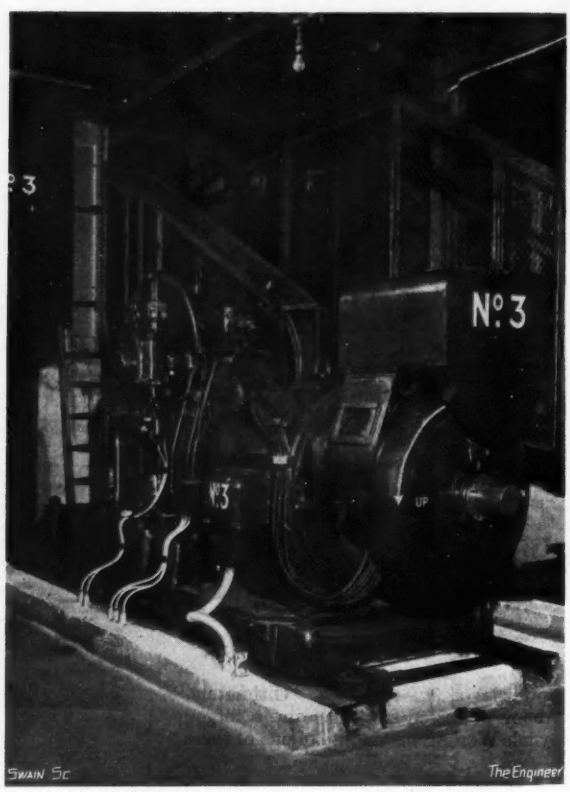
We are indebted for the photographs from which our illustrations have been prepared to Mr. C. H. Lea, Member of the Trades Historical Society.

A.C. Escalator Drive

WE have received from London Transport particulars of a new a.c. motor drive for escalators, which is now undergoing trials at a London station. Hitherto all London Transport escalators have been driven by d.c. motors, but the particular type of a.c. motor to enable the escalator speed to be varied over the wide range required is now well developed, and it was felt that, with a view to future developments, some practical experience should be gained of the use of such motors and equipment for this purpose.

Accordingly, one of the new escalators installed at Bethnal Green Station has been equipped with an a.c. commutator motor and control gear. This particular escalator has a rise of 30ft and normally runs at a speed of 120ft per minute. Three other speeds are required on a machine of this type, an "inching" speed of approximately 30ft per minute for maintenance and inspection purposes, a half-speed of 60ft per minute for use in connection with photo-electric cell control, and an overspeed of 150ft per minute for the purpose of checking the overspeed governor adjustment. On longer machines a fifth speed is required, as the maximum speed permitted in the "down" direction is less than the maximum for the "up" direction.

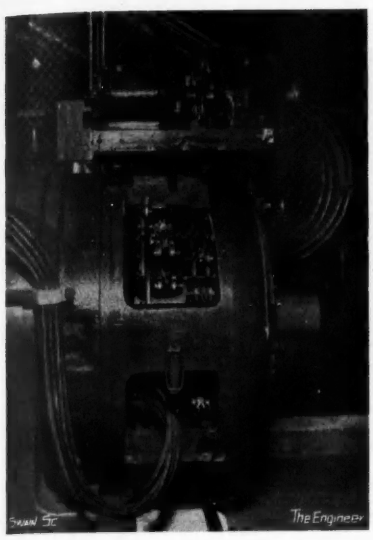
The equipment, supplied by the British Thomson-Houston Company, Ltd., includes a Schrage type a.c. variable speed commutator motor of 25 h.p. continuous rating with a maximum rating of 40 h.p. The speed range is 1190 to 250 r.p.m. and the power supply is at 650V, three-phase, 50 cycles. The speed of the motor is varied by altering the position of the brush gear, which consists of two sets of brushes which can be rotated in opposite directions through an arc of about 40 deg. The change in brush position is effected by means of a small pilot motor operated automatically by the control gear. From the operating point of view the machine is exactly the same as other London Transport escalators



A.C. COMMUTATOR MOTOR DRIVING ESCALATOR

in that it can be started and stopped by means of the special key with which the traffic staff are supplied, and has the usual emergency stop switches at top and bottom for use either by passengers or staff. It is also fitted with photo-electric cell control similar to other escalators at stations where the traffic in the slack hours is very light.

This particular type of electrical equipment was chosen in preference to an alternative type of a.c. commutator motor in which the speed is controlled by a variable induction



MOTOR BRUSHGEAR AND PILOT MOTOR

regulator, as the latter would have involved additional equipment, a feature to be avoided as far as possible in view of the limited space normally available in machine rooms.

In considering new installations regard must be had to the fact that the a.c. supply for most London Transport sub-stations is at a frequency of 33⅓ cycles, although at some the supply is at 50 cycles. Equipment must therefore be suitable for use on either of these frequencies and for conversion from one to the other if such an alteration in the supply should take place.

We reproduce herewith photographs of the motor brushgear showing the pilot motor and gear for varying brush position, and a general view of the escalator drive.

Transport Developments in London

DETAILS of a number of important projects which London Transport has on hand were given by Lord Latham at a recent Press conference.

The construction of the extension to the Bakerloo Line from Elephant and Castle to Camberwell will be started in January next with the sinking of five shafts from which tunnelling is expected to start in February or March. The work of building this 1½ miles tube extension will involve the excavation of over 150,000 tons of earth. All of the tunnelling will be carried out in compressed air owing to the high water content of the ground on the line of route. The terminal station at Camberwell Green will have three platforms, all below the ground, with escalators and staircases leading up to ground level.

In addition to providing a new service in South London the extension will give improved reversing facilities for trains and permit an increase of 25 per cent in the frequency and capacity of the service over the existing line.

An interesting innovation on the rail side of London Transport working will be the introduction in the autumn of a mobile radio network to cut down delays caused by underground breakdowns. A fleet of ten breakdown vans will be linked by radio telephony with a control centre at Earls Court, and, where the vans cannot get sufficiently close to a job, "walkie-talkie" sets with a range of about 1 mile will provide an extra link with the control. By these means urgent requests from the engineering gangs on the spot for more men or special equipment to clear the trouble will be radioed by the mobile vans and relayed by four receiving stations situated at East Finchley, Harrow, Leytonstone and Clapham. To send outgoing messages to the vans a 100-W transmitting station in the tower at London Transport's headquarters will be used. This new system, which has been evolved from earlier experiments, will considerably help the work of engineers when dealing with a breakdown in any part on the system.

ROAD TRANSPORT WORKS

Preliminary works are in hand for the conversion of the South London trams and the changeover from tram to bus operation will begin in October, 1950.

The conversion of tram depots to accommodate buses involves much work as the pits situated between the lines and the roof supports make such depots unsuitable for buses. At the first three depots to be converted to bus working—Wandsworth, Clapham and Camberwell—pits are being filled in whilst the trams are still in service, and special overhead wiring is being installed to allow both buses and trams to use the depots during the conversion period. It is hoped to start the work of converting the tram depots at Streatham, New Cross, Abbey Wood and Thornton Heath for bus working next January. Work on the construction of two new bus garages will commence early next year; one at Stockwell will provide accommodation for 200 buses and the other at Peckham for 125 buses. The cost of the garages and depot works will be £2,800,000.

As trams are replaced by buses and are taken out of service, they will be broken up at a dismantling yard being laid down at Charlton.

Work on the modernisation of the bus fleets in London is proceeding fairly well and it is hoped that next year some expansion in services will begin. During the current year some 1600 new buses will be introduced, although during this period a rather larger number of the oldest pre-war vehicles will have to be withdrawn from service.

In order to provide accommodation for buses a programme of garage building and reconstruction has been started upon. In addition to those covered by the tram depot conversion, work on seven new or reconstructed garages, costing some £1,800,000, will be started this year and next.

The above works are amongst the immediate plans for improving passenger transport in London and beyond them are the far-reaching works proposed by the London Plan Working Party, the report on which has been published by the Minister of Transport.

The Institution of Mechanical Engineers

CLAYTON FELLOWSHIPS AND MANVILLE SCHOLARSHIP

UNDER the Clayton and Manville Bequests the Institution of Mechanical Engineers has just made the following awards for post-graduate training or research in Mechanical Engineering. The awards amount in all to more than £2200 for the academic year 1949–50.

Clayton Fellowships, 1949.—Mr. F. J. Edwards, B.Sc.(Eng.) (Manchester), G.I.Mech.E. (Prescot, Lancs.), for research at Manchester University on "Energy Losses in Divergent Tapering Water Turbine Draught Tubes with a view to Improving Efficiency."

Mr. Frank Ellis, B.Sc. (Eng.) (London) (Oswestry, Shropshire), for research at the Imperial College of Science and Technology for "A Theoretical and Experimental Investigation of Certain Aspects of Hot and Cold Rolling, Including the Application of Photo-Elastic Methods and the Effect of Lubricants on Surface Finish."

Clayton Grant, 1949.—Mr. R. D. Richardson, B.Sc.(Eng.) (London), G.I.Mech.E. (London), for post-graduate study at Cambridge University on "Problems Related to the Control of the Boundary Layer."

Manville Scholarship, Supplemented by a Clayton Grant.—Brian Mills, B.Sc. (Eng.) (Birmingham), G.I.Mech.E., (Birmingham), for research at Birmingham University on "The Flow of Gas Through Poppet-Type Exhaust Valves at Sub-Sonic and Supersonic Velocities."

Renewal for a further year of Clayton Fellowships.—Mr. A. J. Barnard, B.Sc.(Eng.) (London), G.I.Mech.E. (Sevenoaks, Kent), for the continuance of his research at the Imperial College on "The Thermal Data Applicable to Binary and Ternary Mixtures in connection with the Design of Plant and the Development of Processes to Separate Industrial Gases by Liquefaction."

Mr. J. W. Fitchie, B.Sc.(Eng.) (London), G.I.Mech.E. (Preston, Lancs.), for the continuance of his research at Manchester College of Technology on "Fatigue Properties with Special Reference to Stress Concentrations to be Evaluated by Photo-Elastic and Other Methods."

Marine Growth Control at American Power Stations

AT a recent meeting of the American Society of Mechanical Engineers, held in New London, Connecticut, considerable attention was devoted to the serious problems created by marine growth accumulations in the circulating water systems of large seaboard power stations. Of the various forms of marine growth encountered, the mussel was considered to be not only the most common, but also the most difficult to control. Referring particularly to the control of marine fouling where sea water is used for cooling purposes, Mr. Harold E. White, of the Stone and Webster Engineering Corporation, Boston, said that tests had demonstrated the great practical influence of very moderate changes of temperature of the sea water in extermination of mussels. Any elevation of temperature reduced the required consumption of chlorine, which is the most commonly used form of killing agent. For plants with suitable arrangements and load conditions, it appeared practical to achieve positive control of marine fouling in tunnels without the aid of chlorine or other chemicals merely by periodic increases of sea water temperature to not more than 95 deg. Fah.

Another speaker, Mr. I. A. Patten, superintendent of the Lynn Gas and Electric Company, Massachusetts, outlined experiments and the development of a chlorine decontamination scheme at that company's generating station. Such methods as manual removal, electrocution and temperature treatment by steam or hot water had proved to be impracticable at that particular station, he said. A programme of continuous chlorination during the times when the mussels were propagating and until water temperatures dropped to 40 deg. Fah., had been in force since June, 1948, and had resulted in considerable savings in operating costs. Over 20,000 dollars alone had been saved in obviating the need for intake tunnel cleanings, reduced condenser troubles, and the maintenance of a higher vacuum with the resultant reduction in coal consumption. Deducting from this the gross operating costs of the chlorine plant, the estimated net saving for the year had totalled 12,000 dollars.

POWER SYSTEM ANALYSIS.—Owing to the number of applicants who could not be admitted to the Vacation School on Power System Analysis, which was held at Imperial College, London, last April, the course is being repeated during the week September 19th to 23rd.

Stereoscopic Radiography*

By F. HARGREAVES, A.R.S.M., D.I.C., F.R.I.C., F.I.M.†

A RADIOGRAPH is a projection of the characteristics in the part on to the plane of the film and to interpret the nature of any markings shown these have to be replaced mentally in the actual position in which they exist in the weld. This involves the correlation of the indications on the film with the actual defects as revealed by destructive examination of the weld. In this way it is possible with sufficient experience to interpret satisfactorily most radiographs, but cases frequently arise where two experienced observers fail to agree or are unable to come to a definite conclusion, and in such cases stereoscopic methods will usually clear up the difficulty. The writer has in mind, of course, critical welding such as that of boilers. When it is merely a question of the location in depth of a slag inclusion to enable a decision to be made as to the side from which the gouging out is to be done, then a "tube shift" and geometrical construction will give the answer, but by means of efficient stereoscopic radiographs it is possible to see everything in the position in space in which it is actually situated.

The first attempts at Eastleigh were rather disappointing and the writer sought information on the subject, but whilst numbers of people had tried the method, it appeared that it was not really in actual use. At a radiological meeting one speaker of standing in the welding world dismissed the matter by saying that it was merely an advertising stunt. Inquiry in medical circles showed a similar state of affairs. As the method in principle offers a means of seeing every part in its true position and in its actual shape in three dimensions, it appeared that there must be something lacking in the methods used. This is not an occasion for a full discussion, but it should be recalled that vision is only partly an optical process and unless one eye "knows" that the other eye is looking at the same object, vision as we know it in everyday life would not exist. Stereoscopic vision involves the recognition of the object by each eye simultaneously and without effort. The nondescript shapes of defects in a weld and the (to the writer) unfamiliar patterns on a stereoscopic pair of a human head do not afford such recognition. In the writer's opinion a stereoscopic pair cannot be called really good unless it can appear stereoscopic to a person who has no idea of what the object is. The methods outlined here satisfactorily fulfil this condition in their present application, but it must be emphasised that ability to obtain stereoscopic effect varies from one person to another and to some it appears impossible.

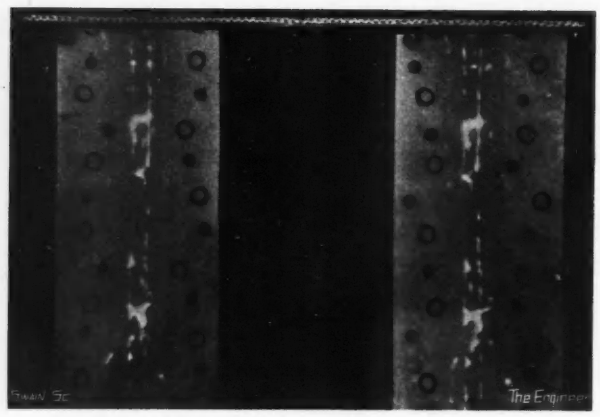


FIG. 1—DEFECTIVE DOWNHAND WELD

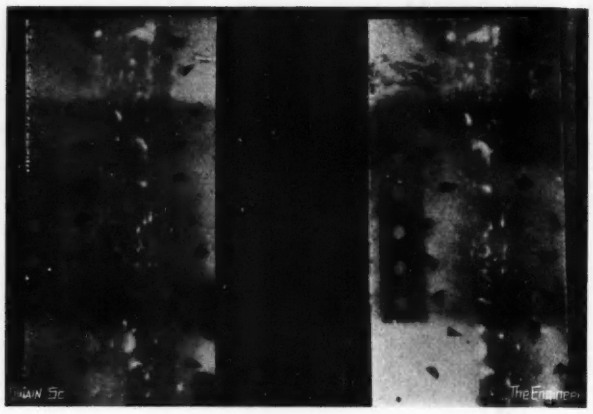


FIG. 2—VERTICAL WELD

When making the exposures for the individuals of a stereoscopic pair a standard of 30 deg. has been adopted as the angle between the direction of the rays in the two exposures, but this is not critical and other angles between 15 deg. and 45 deg. are used on some occasions.

The viewing distance of the pair may be anywhere from about 9in upwards and the greater the viewing distance the greater the apparent thickness of the object. With a good stereoscopic pair it is quite easy to many observers to obtain proper stereoscopic effect without the use of any viewing instrument.

The descriptions of the illustrations are those seen using an instrument which has two totally internally reflecting prisms and these cause a reversal of the picture. If they are viewed in an instrument which does not use reflection then what is referred to in the text as "front" will be the back and vice versa.

The penetrameter in the radiographs has six steps, the thinnest being 0·005in in thickness, and each step increases by that amount. The holes in each step are $\frac{1}{16}$in and 0·05in diameter respectively.

The device adopted to obtain good stereoscopic effect is to stick to the upper and lower surfaces of the sample lead markers of suitable shape cut from lead foil 0·006in thickness. These have the effect of compelling the eyes to focus themselves in such a way that stereoscopic effect is obtained and also retained whilst the eyes move from place to place in the weld.

Fig. 1 shows a stereoscopic pair of a very defective downhand weld in $\frac{1}{2}$in thick plate with both sides of the weld ground flush with the plate. The most "compelling" markers possible have been used. The number 645 can be seen stamped on the front surface, the distribution of the radiographic voids can readily be seen and undercut on the front surface is visible. Lead intensifying screens were used in making the radiographs.

Fig. 2 shows a stereoscopic pair of a vertical weld in plate of $\frac{1}{2}$in thickness using markers less compelling (and less distracting) than those of Fig. 1. The front surface is marked with scalene triangles and the back with semicircular discs. The lower symmetry of the shapes of the markers as compared with circles makes a contribution to the stereoscopic effect. The weld metal has been ground flush with the surface of the plates, and close examination enables the following interpretation to be made.

(*a*) The first run by the "make-and-break" method has failed to make the weld metal level with the back surface in places.

(*b*) Imperfect fusion within the first run is present in places.

(*c*) There is repeated failure to fuse the sides of the parent metal in the second and third runs.

(*d*) The subsequent runs show a great improvement in this respect, and they are good in other respects, but not perfectly free from defects.

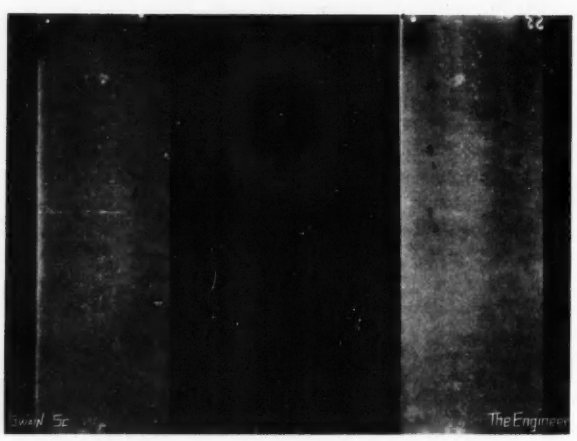


FIG. 3—WELD PRACTICALLY FREE FROM FAULTS

(*e*) A little undercut is present on the front surface.

In addition to these weld characteristics, the six steps of the penetrameter can be seen, and the large and small holes down to the thinnest step are visible and this represents a sensitivity of 1 per cent. The penetrameter can be seen in relief.

The length of the weld shown is 5$\frac{1}{2}$in and across each film a dark band 3in wide is seen. This is an effect of the salt intensifying screens which were used. These 6in wide screens have

* Excerpt from "Welding in Locomotive Construction and Repair," Institute of Welding, Southampton, April 27th.

† Chemist, Eastleigh Works, S.R., British Railways.

been used a great deal with film 3in wide by 15in long and these two particular films were taken with the length of the film across the screens. At the place of repeated contact between 15in and 3in films and the screen, the screen has become less sensitive.

Fig. 3 shows a stereoscopic pair of a weld in ⅜in plate which is practically free of faults except that of porosity. The weld has been ground flush with the surface of the plate. It is shown as an example of what it is possible to see when using suitable stereoscopic methods. Each individual speck of porosity can be seen in its position in three dimensions. Inconspicuous scalene triangles are used as markers over half the length of the weld, and these suffice to give perfect stereoscopic effect on that half. It can be stated that the practiced observer can cover up the marked half and still get some stereoscopic effect, but it is very imperfect. Lead intensifying screens were used in taking the radiographs.

It is perfectly practicable to obtain stereoscopic pairs of welds with the reinforcement left on.

The Admiralty Transmitting Magnetic Compass

(By Our Naval Correspondent)

UNTIL the early years of this century a compass was required for the sole purpose of correctly orientating the ship and such objects as were in visual sight from her. Indeed, in a merchant ship this was the only use of a compass until quite recent times. Apart, therefore, from the standard compass, a battleship needed a compass at the steering position, another in the armoured conning tower, from which position the ship was steered and controlled in action, and one in the after control position in case of damage to the ship forward. Then came the introduction before the 1914–18 war of fire control with the consequent necessity for repeat compasses in the transmitting station and other positions in various parts of the ship—a requirement which was met by the gyro compass.

Apart from submarines, the gyro compass was only required in large ships, for even a destroyer of those days had a very primitive fire control system. In submarines the gyro compass was essential for other reasons—for steering and navigation when submerged. For although these vessels also had a magnetic diving compass, housed in a watertight fitting in the superstructure with a system of reflecting mirrors to the steering position inside the ship, the compass needle had an unfortunate habit of wandering several degrees, depending on the output of the batteries with the variations in speed.

The second World War brought with it automatic navigational instruments and radar and precision weapon control; and even the smallest of H.M. ships, including the light coastal forces, found themselves in need of a repeating compass to co-ordinate the plotting, radar and executive functions in fighting the ship. Unfortunately a gyro compass, although it had meanwhile been fitted in many destroyers as they became larger and more heavily armed with a fire control system based on the principles of a large ship installation, was not a practical proposition for these small ships. It requires a good deal of space, technical knowledge and facilities for maintenance, and it will not stand up to the severe shocks and accelerations which the small ship is called upon to withstand. In a submarine, for example, when under way on the surface with a good deal of motion on the ship the master gyro would frequently be thrown off in a heavy sea. It was thus essential for the helmsman, who steered by means of a gyro repeater from a position inside the submarine, to check the repeater, at frequent and regular intervals, with the reflection of the diving compass alongside it. With the diesel engines only running the diving compass was, of course, quite reliable.

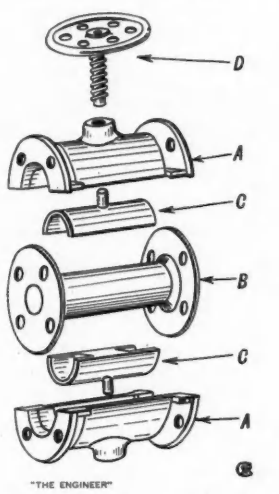
As a result of this new and essential requirement for compass-operated instruments in all kinds of naval vessels and aircraft, the Admiralty Compass Observatory set to work and produced the Admiralty transmitting magnetic compass. As its name implies, it is one in which a master magnetic compass, through an electrical "pick-up" system, a simple valve amplifier and "follow-up" system, was enabled to operate as many repeaters as were required. The system used, that of a liquid Wheatstone's bridge, formed in the compass by the use of electrodes in the bowl and on the card and using the actual liquid as a resistance path, was originally invented by Mr. E. L. Holmes, but the compass designed by the Admiralty Compass Observatory makes use of modern electronic technique with all its advantages, and has enabled a simple, accurate and robust instrument suitable for small fast craft to be evolved.

There are several types of the "A.T.M.C.," one of which is suitable for larger vessels, such as destroyers, with a transmission capacity equal to the gyro compass. The master compass can be mounted either as a steering or as a standard compass, and if the electrical supply should fail it retains its use as a simple magnetic compass. Transmission from the "A.T.M.C." provides a useful alternative to that of the gyro compass for stabilising the radar plan position indicator, or orientating the automatic plot.

In merchant vessels the introduction of radar and other electronic navigational aids is to-day rendering the need for a transmitting compass imperative. The employment of a transmitting magnetic compass for such purposes will provide a reliable and inexpensive solution to the problem both in commercial vessels and the smaller warships. A small "A.T.M.C." is used also in some aircraft for working automatic dead-reckoning instruments, and is useful in cases where the larger R.A.F. distant-reading compass cannot be fitted. It may well be, indeed, that the new series of instruments, based on the use of the oldest and most reliable form of compass known, that employing the pivoted needle, will give this ancient device a new lease of life.

A Straight-Through Valve

The accompanying illustration shows the components and construction of the Warren straight-through valve, of which we have been sent particulars by Warren, Morrison, Ltd., 4–6, Palace Street, Westminster, S.W.1. It has particular applications in the chemical and food industries, for its design is such that a full-bore opening is obtained, giving no flow restriction or churning effect. It is light in weight and can be supplied with any of four natural and synthetic rubber inserts, to resist the effects of most chemicals.



STRAIGHT-THROUGH VALVE PARTS

Reference to the sketch shows that the valve comprises two identical half-body castings *A*, which enclose a flexible synthetic rubber moulding *B*. This moulding is tubular, formed in one piece, with end flanges for the pipe joints. Anvils *C* within the body halves are squeezed together by screwing down the hand-wheel *D*, compressing the moulding between them. These anvils are formed with broad, flat faces and curved edges, to avoid damaging the moulding.

These valves are made in eight sizes from ⅜in to 3in bore, suitable for 100 lb per square inch pressure in the four smaller sizes, 75 lb in sizes 5 and 6, and 60 lb in sizes 7 and 8.

Standard Plain Bearings and Bushes

LAST week we were given the opportunity of visiting the works of the Glacier Metal Company, Ltd., at Alperton, Wembley, Middlesex, and of hearing its plans in connection with a programme of standardisation of its products. Some of the relevant points of the plan are discussed on page 148, but further details are given in what follows.

The programme was started some two and a half years ago with a series of standard wrapped bushes. Forming these bushes from strip by rapid pressing operations makes them inexpensive. They are made from a bi-metal material, steel strip lined with lead-bronze, the alloy being firmly bonded to the steel backing by a sintering process, prior to which the steel backing itself is copper-plated to avoid rusting. The strip is formed into butt-jointed bushes, which are claimed to be superior to phosphor-bronze solid bushes in mechanical strength and bearing qualities. The standardisation in this case is by bore, length and housing size in both inch and metric dimensions, and additionally by sizes of oil holes and grooves in the inch sizes. More than 200 inch and 150 metric sizes are stocked. They are supplied with a finishing allowance in the bores and are as standardised an article as it is possible to imagine.

The next stage in standardisation followed almost at once, when the company embarked on a series of thin-walled, bi-metal strip, prefinished half bearings for shafts up to 4in diameter, designed for automobile and commercial vehicle engines, and for small diesel engines. With engine bearings it was not considered advisable to standardise on dimensions other than outside diameter and wall thickness. Full standardisation was felt to be an ideal which could not be achieved, the argument being that, broadly speaking, the length of an engine is largely controlled by the length of the main bearings. Many designers fit the main bearings into the spaces left between the cylinders and permitted by the design of the crankshaft, and so arrive at as short an engine as possible. Thus, if the standard list left the designer with the option of using a bearing as little as ⅛in longer than the minimum which the basic design made necessary, he would not accept it, because it would mean adding to the length of the engine, nullifying any saving arising from the use of a standard bearing. Conversely, if the nearest standard were slightly shorter than the ideal dictated by the design, essential bearing area would have to be sacrificed, which would be equally unacceptable. The plan was therefore confined to a limited approach to standardisation of half-bearings, with the object of obtaining a standard range of tooling and of raw materials. Bearings so produced can be practically of any length, they can have any design of oil grooves, gutter ways or oil holes, and can have a wide variation in thickness by selective choice of the size of shaft. The outside diameter is, however, in all cases standard, because then standardised pressing operations can be used. As we have indicated on page 148, the plan has met with considerable success, for each of the sizes originally proposed has been taken up by at least one engine builder.

Now the firm announces that it will proceed a stage further, by manufacturing a standard type of half-bearing for shafts from 4½in to 10in diameter, thus entering the heavy stationary and marine diesel engine field. Two ranges are to be made, with standardised

outside diameters and wall thicknesses; a "thin" range, which is expected to have the widest possible field of application, and a "thick" range, intended only to cover applications where it is necessary to provide deep oilways and joint-face dowel pins, &c., which could not be accommodated in the thin range. Twenty-four nominal bore sizes, increasing in ¼in steps, are proposed for each range. It should be noted that the nominal bore dimension can be adjusted to provide the correct running clearance for each particular application, and, of course, other features, such as overall length, oil grooves, dowel holes, &c., can be decided freely for each application. Bearings in either range can be supplied prefinished or with an allowance for scraping, and the lining material may be tin-base white metal, lead-bronze or any other required alloy.

Committee on Patents and Designs Bill

A JOINT committee of the F.B.I. and the Trade Marks and Patents Federation has considered the Patents and Designs Bill (which has now been approved by both Houses of Parliament) and raised a number of points of general principle on which useful alterations have been obtained.

A clause in the Bill deals with the rights of any interested person if the patent covering an invention is abused. For example, if the demand in the U.K. for the patented article is not being met at a reasonable price, an interested person may apply for a licence, which gives him the right to manufacture under royalty. Somewhat similar powers were given to any Government Department, which can now apply to have a patent endorsed "licence of right," giving any person the right to demand a licence on terms to be fixed by the Controller. The procedure governing the application of any interested person was subject to a number of safeguards, but the procedure governing the application of a Government Department was free from these safeguards. As a result of representations, the same safeguards, where relevant, now apply to a Government Department.

An example of one of these safeguards is that application may be made to the Controller on the ground that a market for the export of the patented article manufactured in the U.K. is not being supplied. The reason may be that the inventor or owner of the patent has found it pays better to licence a foreigner to manufacture and to receive royalties. It may well be in the national interest to secure as much foreign exchange as possible and, if this course pays better, then it follows that more foreign exchange would be secured. The Controller, in exercising his powers when dealing with any application, is directed to secure that inventions which can be worked on a commercial scale in the U.K. and which should, in the public interest, be so worked, shall be worked without undue delay and to the fullest extent reasonably practicable. The Controller would then at this stage adjudicate on whether it was in the public interest to give the applicant a licence. Again, the Controller in deciding whether to make an Order in pursuance of any such application, is to consider the nature of the invention, the time which has elapsed since the sealing of the patent, and the steps taken by the patentee to make full use of the invention. He is also directed to secure that the inventor shall receive reasonable remuneration having regard to the nature of the invention. The amendment has the effect of requiring the Controller to apply the same considerations when dealing with an application of a Government Department as he originally had to apply if the application was from an interested person.

Although the Government has a right to use patented inventions, compensation for such use is payable to the patentee. Recently there has been some complaint that the patentee was hindered in claiming this compensation by being left in the dark by Government Departments as to whether they were using these inventions and on the extent of such use. Following representations, a new provision has been inserted making it clear that, unless it is contrary to the public interest, a Government Department must notify a patentee of such use and of its extent.

During the passage of the Bill a new clause was put down seeking to regulate the profession of patent agent. This is a controversial point. No one objects to a requirement that a man must be properly qualified before he holds himself out to the public as a patent agent. There is, however, a difference of opinion on whether it is permissible for a limited company to employ whole-time on patent work a man who is not recognised by the Institute of Patent Agents. It is felt by some that a limited company should be free to employ whom it pleases. On the other hand, there are some who believe that a man employed whole-time on patent work should be a registered patent agent. It is pointed out by those who hold this latter view that, unless such an individual is registered, all his assistants are debarred from becoming qualified patent agents because they cannot serve the necessary number of years with a qualified person. A new amendment to the Bill sought to make it obligatory, unless special exemption were obtained from the Controller of the Patent Office, to have such an employee fully qualified and registered as a patent agent. However, it was not clear what the position would be for those at present in such employment. In the past, where any profession has been made a closed profession, those engaged in it have always been given the opportunity to get on the register. As a result of discussions with the Institute, it was readily agreed that such an opportunity should now be given. This result will be secured by rules to be made under the Act.

Canadian Engineering News

Heat Pumps

In order to keep abreast of a development, which, if widely adopted, would create heavy additional demands for electric power, the Research Division of the Ontario Hydro-Electric Power Commission for the past three years has been making a comprehensive study of heat pumps. An experimental installation was completed recently at Wiltshire Transformer Station in Toronto. This heat pump is being used both for experimental tests and the practical purpose of heating the station in winter. In addition, the Commission is taking advantage of an opportunity to obtain detailed performance records from two domestic heat pumps, one near Islington and the other at Kitchener.

The heat pump at Wiltshire Transformer Station is electrically driven by means of a 5 h.p. motor. The heat source is the water which is circulated to cool the transformers. A small portion of this water is passed through the heat pick-up coil in the heat pump, where its heat is extracted and used to heat the building. The transformer cooling water, at temperatures varying from 50 deg. to 70 deg. Fah., is almost an ideal heat source. Hence, in this installation the problem of obtaining a suitable heat source was a minor one. This unit is a good example of an industrial application of the heat pump and is convenient for the investigation of many factors, such as mechanical performance, noise, operating costs and characteristics. To provide cooling in the summer, the method of operation will be reversed, and heat from the building will be carried away by the transformer cooling water. In order to do this it is necessary merely to reverse the action of the coils. In other words, in hot weather the heat pick-up coil will be used as a heat discharge coil and vice versa.

The domestic heat pump in a private home near Islington is smaller than the Wiltshire Street installation and is being used to heat a four-room, single-storey house. It is driven by a 3 h.p. electric motor. The heat source being tested is a well 6in in diameter and approximately 175ft deep. In this particular application, the well water is not used directly, but the heat is extracted by circulating an anti-freeze mixture of water and alcohol through 350ft of 1in pipe immersed in the well. After taking up heat in the well, the circulating mixture is pumped through the heat pick-up coil in the heat pump, where it gives up its heat to the refrigerant. The anti-freeze mixture is then recirculated through the pipe in the well. The purpose of this circulating mixture is merely to act as a go-between in transferring the heat from the well water to the refrigerant in the heat pump. This extra step in providing an intermediate circulating mixture is necessary, as the flow of water into the well is limited. Consequently, the water level would be lowered seriously if the water were pumped from the well and discarded after the heat had been extracted from it.

The unit under study at Kitchener uses heat from the earth to heat a well-insulated five-room single-storey house. It is driven by a 3 h.p. electric motor and provides winter heating and summer cooling. Unlike the Islington installation, there is no intermediate circulating fluid, the refrigerant being passed directly through a heat pick-up coil buried in the earth. This coil consists of a horizontal loop of copper tubing ¾in in diameter and approximately 500ft in length, placed at a depth of 6ft. Temperature measuring devices have been placed at various depths and selected distances from the loop. From time to time temperature readings are taken of the earth surrounding the pick-up coil to provide an indication of the amount of heat that is being extracted.

According to the Commission's technical experts, the use of water as a heat source for domestic heat pump installation in Canada is not too promising. Possibilities exist, however, adjacent to year-round flowing water or to deep wells in which water is renewed at moderate rates by underground circulation. Such conditions are not generally available in Canada, though some favourable sites can be found, especially in areas not heavily populated.

Aluminium Project

The Aluminum Company of Canada is contemplating construction of a hydro-electric and aluminium plant in the coastal area of British Columbia at an estimated cost of between 300 and 400 million dollars. It has appropriated 900,000 dollars for engineering investigation during this year and next. Attention is being directed to the Tweedsmuir Park area, 60 miles from the coast and about 120 miles west of Prince George. If the plan is adopted the water from lakes Whitesail Tahtsa and Eutsuk will be impounded over a large area and two tunnels, each 9 miles long, will be constructed. In addition, a power plant will be built on the Kemano River, to generate 2,200,000 h.p. At present, test drilling is under way at Nechako Canyon, where the dam would be erected. The preliminary work will take two years and will be largely concentrated upon the dam site and route of a power transmission line between the Kemano River power plant and Kitimit at the head of Douglas Channel. At the latter point an aluminium plant would be built with tide-water outlet, permitting delivery of ocean-borne supplies of bauxite from the great deposits at Kitimit. Mr. McNeeley Dubose, vice-president of the company, recently stated that he felt optimistic that the project will go ahead, but no definite decision was possible yet.

New Power Unit

The second unit of the British Columbia Electric Company's Bridge River plant has been placed in service. This unit adds 62,000 h.p. to the company's output. With the third unit of the project scheduled to be completed next autumn the company will have a surplus of power in the area it serves. Sale of surplus power is contemplated in the North-West United States, where a power shortage is anticipated for several years. By the end of this year the company will have spent more than 23,000,000 dollars on the Bridge River hydro-electric project, of which 3,800,000 dollars will be for the La Joie storage dam, scheduled for completion next autumn.

A Shock-Resisting Plastic Moulding Material

THERMOSETTING plastics have been warmly welcomed by designers of electrical apparatus, who find in them materials of construction which fulfil functional requirements as regards insulating properties, heat resistance and mechanical strength. The compounds are easy to mould, and the finished articles have a pleasing appearance and excellent wearing properties. Thus, in addition to the fact that, say, an apparatus housing, moulded in thermosetting material is electrically "safe" the high, natural gloss of the article and its "moulded colour" allows, in many cases, a substantial reduction in costs. The number of manufacturing operations is much smaller in the case of thermosetting plastics than with metals.

The decision whether to use metals or thermosetting plastics has therefore been easy, and when electrical properties have been the consideration, the newer materials have always been preferred. But the question arises whether plastic moulding materials can prove their value on mechanical strength only. The tensile strength of thermosetting mouldings is, of course, lower than that of the common metals. The comparison has, however, a different aspect when one considers the strength-weight ratio of the materials, and a cellulose-filled phenolic plastic can successfully compete with the usual metals of construction when tensile or flexural stresses are considered.

These moulding compounds are also suitable for applications where high resistance to shock is required. The nature of the fibrous filler contained in the compound determines the resistance of the moulding to the impact of a relatively large force which may act suddenly on the moulded article. When mouldings are subjected to mechanical shock, and there is not enough time for the stress to distribute itself evenly, the filler has to absorb the mechanical shock waves and to prevent failure.

A new material, "Rockite 3932," which has been developed by British Resin Products, Ltd., 21, St. James' Square, S.W.1, contains a filler which possesses high damping capacity and consequently is claimed excellently to fulfil this function.

Fibrous fillers form an important constituent of moulding compositions. Apart from reducing the cost and improving the handling properties of the resin during processing, their chief function is the improvement of impact strength. During flow, the fibres do not dissolve in the resin but form with the bonding agent a non-homogeneous mixture. They are capable of absorbing mechanical shock waves and will prevent propagation of microscopic surface blemishes through the moulded article.

In developing the new material, the company approached the problem of improving the surface and increasing the impact strength of moulded products from a new angle. It had been found essential to the satisfactory absorption of mechanical shock waves that the filler particles should overlap over a considerable portion of their total length. To a certain extent this condition was fulfilled with diced fabric compounds. Owing to the stiffness of the individual diced pieces or flakes, laminated structures were often formed which showed weaknesses in certain directions. A twisted yarn or cord proved, it is claimed, to be the filler which had all the desirable properties. Built up from cotton fibres of good absorptive properties, it takes enough resin to render the finished moulding sufficiently resistant to moisture. The right amount of "twist" in the cord is important; it gives strength to the individual filler particles and controls the resin absorption. The length of the cord particles can conveniently be adjusted to suit the requirements of flow and strength.

The manufacturing process for this new material consists mainly in the treatment of the filler with a liquid, phenolic resin of fast cure. The conditions have to be carefully adjusted in order to maintain the valuable "twist" in the cord. A process has been evolved which fulfils this requirement. After blending, the moulding mixture undergoes a controlled drying and re-blending process, from which it emerges as a resin impregnated "flock" ready for packing in steel drums. Stringent control tests for physical and moulding properties are carried out in the intermediate stages of manufacture and on the final moulding compound.

As a thermosetting moulding compound, "Rockite 3932" is said to have all the desirable properties of this class of plastics. It is rapid setting, and gives mouldings which show good gloss, and do not require any after-treatment, such as polishing, &c. It is available in its natural shade and also in a number of colours, useful for identification purposes in electrical and similar applications. The new material complies with the requirements of B.S. 771 in regard to electrical and mechanical properties; its impact strength is a multiple of the requirements of this specification. Other properties are tabulated below :—

Properties of "Rockite 3932"	
Specific gravity	1·38
Weight per cubic inch	0·80 oz
Bulk factor :	
Volume of compound/volume of moulding	5·2-6·3 (for hand compressed powder).
Moulding Contraction	4·5-6·0 thou./in
Cross breaking strength (Method to B.S. 488)	6000-8000 lb/sq in

The material should be moulded at 300 to 330 deg. Fah., under pressure of 1 ton per square inch and higher, taking into account the "draw" of the moulded piece. Headroom in the mould should be provided according to the bulk factor in the Table. For loose compound "positive" moulds are necessary. "Rockite 3932" can easily be pre-formed, and then it can be used in any type of mould. Infra-red oven or electronic pre-heating methods are applicable. We understand that transfer moulding—the method in which the compound is softened in a separate part of the mould, and then forced into the mould cavity, where it heat hardens—has been successfully applied to "Rockite 3932," and that a very uniform cure is achieved in this way. This is said to be probably the best method to obtain complete hardening even on mouldings of large cross sectional area and intricate design.

South African Engineering Notes

(From our South African Correspondent)

Railway Coaches

South African Railways have just tested a new coach equipped with fluorescent lighting and a water supply pumped and heated by electricity. Three years of research preceded the introduction of the lighting, and the Railway Administration claims that it is the first to use 110-V d.c. fluorescent illumination. Certainly, when the South African railways installed ordinary 110-V d.c. lighting in trains in 1940, it was the first time in the world that such voltage had been used for train illumination. Now, hot-cathode fluorescent lamps are being used. The electrical installation on these coaches includes a generator, of 5-kW capacity, which is driven from the axle by means of a belt. Arrangements are embodied to maintain constant tension on this belt under conditions of curvature, which may be as sharp as 300ft radius. The battery required to provide lighting and power for water pumping when the saloon is stationary, or when running at low speeds, consists of fifty-six cells of 150Ah capacity. These cells are charged when the train is running at speeds above 12 m.p.h. The main lighting of each compartment is by four 24in fluorescent lamps, mounted in two fittings covered with plastic. The resulting illumination is about twice that obtained in existing saloons on the S.A.R. and amounts to 15 candle-power on each square foot at reading level. In these new coaches, water is raised from the storage tanks on the underframe to the roof service tanks by means of automatic electrically-driven pumps. A float switch is fitted in the roof tank which brings the pump into use as soon as the water level drops below a set stage. Each saloon is fitted with two pumps, one serving each roof tank. Every wash basin is supplied with hot water and, where shower baths are fitted, they too are provided with hot water. Saloons have two electric water heaters, each capable of delivering ten gallons of hot water at 140 deg. Fah. an hour. Where a shower bath is fitted, a third geyser is installed and a thermostatic mixing valve prevents inadvertent scalding.

Railway Works

The report of the South African Railways and Harbours Board for 1948, which has just been tabled in the House of Assembly, shows that although the number of new locomotives and rolling stock steadily increased during the year, the amount of new stock placed in service was insufficient to keep pace with the expansion in traffic. All records were broken, however, for the number of truck loadings, the 1948 figure being 4,744,919, compared with 4,521,577 in 1947 and 4,362,734 in 1946. The railways also broke all previous records for the conveying of petrol, power paraffin and crude oil, the year's total of 284,000,000 gallons being an increase of more than 36,000,000 on the previous year. While the Government's decision to restrict expenditure on State, Provincial and Municipal capital works schemes has resulted in many of the railways' expansion plans being either cut or "pigeon-holed," it is now believed that work will begin this year on the new 18-storey administrative block in the £6,000,000 railway station planned for Cape Town. This building represents only one item in the railway administration's scheme for improving transport facilities in the Mother City at a cost of £14,000,000. Four other Cape development plans which have escaped the economy axe are the new £2,500,000 marshalling yard and station at Bellville (a Cape Town suburb), the £2,500,000 goods yard on the reclaimed Cape foreshore, the £1,000,000 electric running sheds at Salt River (also a suburb), and the £325,000 carriage yard for main-line stock. The Bellville scheme should be completed by next year. It includes the moving of 300,000 cubic yards of earth to enable the existing two main lines into Cape Town to be increased to seven.

Road Works

Owing to the general cuts in public works schemes, a priority has now been laid down for the road construction programme in the Union. The Minister of Transport, Mr. P. Sauer, has given highest priority to the completion of the tarring of the main Cape Town-Johannesburg road, followed by the tarring of the Cape Town-Durban road. Third in the list is the national road from Aliwal North to Kingwilliamstown. The road from Cape Town to Johannesburg, which goes through Bloemfontein, is more than two-thirds complete. It is doubtful, however, whether the original deadline of 1952 for this work to be finished will be met. When finally open to traffic, the road is expected to reduce travelling time between the port and the Witwatersrand by many hours. Much more work is outstanding on the national road between the Cape and Durban, a landslide in the Wilderness district having added to the difficulties. Two bridges are in course of erection on this road, the first near Swellendam and a larger one over the Kaaiman's River near the Wilderness. An interesting experiment is being carried out on the Great North Road to Rhodesia. The possibility of this road being tarred throughout its length is not immediate politics, so the gravelled surface has been broken by 17 miles of an experimental tarmac formed by scraping the gravel road level and placing a tar compound mixed with sand over it. This surface, which can be laid at the rate of more than half a mile a day, at a cost of about £1200 a mile, has stood up well to four month's wear and the Transvaal Provincial Roads Department is urging that this tarmac be extended to the Rhodesian border as a temporary measure until the national road is built.

Industrial and Labour Notes

Railway Wages

A specially convened delegate conference of the National Union of Railwaymen decided on Thursday of last week to accept the revised terms of reference of the Conciliation Board appointed to examine the railway wages dispute. These revised terms, it may be recalled, exclude employees in railway workshops from the scope of the examination, a decision reached by the Minister of Labour in view of the refusal of the Confederation of Shipbuilding and Engineering Unions to accept in advance the Conciliation Board's suggestions affecting railway shopmen. The Minister therefore stated that the Board's discussions would have to be limited to the grades covered by the negotiating machinery for railway staff, a statement which, in its turn, brought a protest from the N.U.R., of which union some of the shopmen are members.

A deputation from the N.U.R. discussed the matter with the Minister of Labour early last week, and the delegate conference ultimately agreed to accept the new terms of reference. At the same time, it decided that the Minister should be notified that a dispute existed between the union and the Railway Executive over the question of railway shopmen's wages. This means that if the Minister does not intervene within twenty-one days the N.U.R. is constitutionally free to take further action. On Friday last the Minister of Labour announced that he would set up a Conciliation Board to examine the dispute over railway shopmen's wages, the membership of the Board being the same as that already constituted, under the chairmanship of Sir John Forster, to deal with the wages of the other railway workers. The second Board's terms of reference, however, do not provide for the parties concerned to agree in advance to accept its recommendations. If it fails to reach a settlement on any point, it is authorised to make recommendations and to report to the Minister.

Personal Incomes, Costs and Prices

Before Parliament adjourned for the summer recess, the subject of profits, prices and wages was raised in the House of Commons by Mr. Ronald Chamberlain. He recalled the White Paper on Personal Incomes, Costs and Prices, and suggested that it was "very much to the credit of the unions, the T.U.C. General Council, and the general body of workers that the general movement of wage rates had been on a lower level and to a less amount than the movement of retail prices." Mr. Chamberlain went on to say that there could be no doubt that profits had been much too high, a matter which had "a real and detrimental effect on our standard of living, on our internal stability and contentment, and on our ability to gain and retain overseas markets."

Reply to the debate was made by Mr. Jay, Economic Secretary to the Treasury, who gave the assurance that the Government regarded it as an absolutely cardinal element in economic policy that the proposals of the White Paper for restraining increases in personal incomes of all sorts should be followed more intensively now than a year ago. Mr. Jay said that people should realise, when they quoted figures of increased wage rates over the past year, that the productivity per man-year in British industry had been rising, over the past year, at the rate of something like 4 per cent or 4½ per cent, which was higher than the average. So far as profits were concerned with certain exceptions there had been a good response. The percentage of industrial companies which did not increase their dividends over the whole twelve-month period from April 1, 1948, to March 31, 1949, was 93·1, and over the three months March to May of this year the percentage of invested capital on which dividends had not been increased was 88·3, which indicated, Mr. Jay said, that the degree of observance was being continued.

Wage Rates and Working Hours

Changes in wage rates which became effective in the month of June in the United Kingdom resulted in an aggregate increase of about £99,000 in the weekly full-time wages of 360,000 workers. Among those participating in the increases were manipulative grades employed in the Post Office, workers in electricity supply undertakings and in the tin box and other metal container industries, and workmen employed by land drainage authorities. Small increases, through the operation of sliding scales based on the index of retail prices, were also made to iron and steel workers in some districts, and to iron-ore miners and limestone quarrymen in Cumberland.

The publication of these figures by the Ministry of Labour completes the computation of wage rate changes during the first six months of this year. In that period it is estimated that 3,913,000 workers received pay increases amounting in the aggregate to £617,400 a week. In the corresponding months of 1948, increases totalling £997,800 a week were made to 3,376,500 workers. The index of rates of wages (1947=100) stood at 108 for all workers at the end of June, 1949, and has not therefore changed since the beginning of the year. In June, 1948, the index figure was 106.

Changes in hours of work reported to the Ministry during June affected those engaged in the pottery industry, in which the normal working week was reduced from forty-seven or forty-eight hours to forty-four hours.

Trade Disputes

The number of stoppages of work through trade disputes, reported to the Ministry of Labour as beginning in June, was 144, and to that number must be added fourteen stoppages which started earlier and were still in progress at the beginning of the month. The Ministry says that in these 158 stoppages, 47,000 workers were involved directly and indirectly during June, and that the aggregate number of working days lost was 190,000.

The coal-mining industry accounted for 104 of the June stoppages, involving 15,100 workers and showing an aggregate loss of 31,000 working days. In the metal, engineering and shipbuilding industries there were twenty-seven stoppages of work through disputes, and in them 5500 people were concerned, with a resulting loss of 9000 working days. In the stoppages of work in the transport industry—which included Sunday strikes on the railways and the recent dock strikes—22,300 people were involved and 129,000 working days were lost in June.

In the first six months of this year stoppages of work through disputes numbered 822. The number of workers affected by them is estimated by the Ministry as 239,500, and it is stated that 923,000 working days were lost. In the comparable months of 1948, 1055 stoppages were reported, involving 315,200 workers and causing a loss of 1,582,000 working days.

The T.U.C. on Wages and Productivity

When the General Council of the Trades Union Congress met on Wednesday of last week, consideration was given to reports from its economic committee on various aspects of the present situation. The reports were based on discussions which have taken place recently between the committee and the Chancellor of the Exchequer and other members of the Government. In a statement issued after its meeting, the General Council said that "to abandon the general policy of the T.U.C. on the related subjects of wages, expenditure and productivity would be disastrous to the national economy and the interests of trade unionists." Increased income and expenditure, the statement added, would only be made possible through higher productivity. The Council authorised the preparation of a full report and recommendations to be submitted to the annual congress, which is to be held at Bridlington early next month.

The T.U.C. General Council also decided last week to issue further invitations to affiliated unions to participate in its series of conferences on productivity questions. Among unions concerned are those representing building, heating and domestic engineering, shipbuilding, paper making, printing, leather goods, coal mining and steel workers.

Census of Production, 1949

The Board of Trade has announced that, following consultation with the Census of Production Advisory Committee, it has been decided that information shall be collected in less detail for this year's census of production than was required for 1948. For 1949 the principal change is dispensing with detailed particulars of the sales of goods made or of materials purchased. The output and materials sections of the return are to be simplified as far as possible, and for most trades only one total value for output and for materials will be required.

In certain cases, the Board states, one or two other totals which were asked for in 1948—duty paid in the year is one example—will be repeated so as to allow net output to be calculated. Only one total figure, however, will be required for work given out, and the sections on payments for services rendered by other firms and on the analysis of sales are to be omitted. But, although these simplifications will be made for this year, details similar to those called for in 1948, particularly as to materials purchased and output, will be asked for in future censuses. The Board of Trade therefore advises firms to maintain the records of their business which enabled them to complete the forms for 1948. Forms for the 1949 census of production will be issued to all firms concerned on January 1, 1950.

Trade with Canada

At a recent Council luncheon of the British Engineers' Association, an address on the subject of British trade prospects in Canada was given by Mr. L. D. Wilgress, Canada's High Commissioner in the United Kingdom.

In the course of that address, Mr. Wilgress said that there was an effective demand in Canada for machinery and industrial equipment, and expressed the hope that British manufacturers were making such price adjustments as the Canadian market had in recent months required. Price was, of course, not the only factor, Mr. Wilgress continued, as delivery dates and servicing were important matters. The Canadian purchaser of engineering products had been accustomed to quick deliveries and speedy servicing in the case of operating difficulties or breakdowns. On the latter point, Mr. Wilgress said that it would obviously not be possible for British firms to offer servicing facilities comparable with Canadian and United States firms until representation in Canada had been built up, although he thought a start should be made now. As to delivery dates, Mr. Wilgress expressed the view that "something should be done at once," as he understood that contracts had recently been lost because United Kingdom suppliers could not meet delivery requirements. Every priority, he urged, must be given to the completion and movement of Canadian orders. Moreover, British firms must be prepared to supply not the products they had traditionally manufactured, but the particular products which would meet Canadian specifications.

French Engineering News

(From our French Correspondent)

In the course of a debate on military credits, the French National Assembly was told that automobile material was being renewed and maintained by recovery from obsolescent vehicles. More than one milliard francs has been reserved for the purchase of new material. In the last eighteen months there has been a systematic renovation of armament material for the repair of tanks, armoured vehicles, light cars and lorries. Many hundreds of tanks and 2000 tons of spare parts have been purchased from Belgium, and will be ready for use by the end of the year. In addition, a series of prototypes has been developed during the past eighteen months. A light, 12-ton tank has also been tested, and a 55-ton, 1000 h.p. tank is to be tested in September.

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Owing to the continued dry weather, Electricité de France has had to reduce electricity allocations for certain industrial consumers. This measure represents about one-tenth of the reductions which operated during the winter, effecting an economy of 700,000kW a day. In addition, irregular cuts are being made in domestic consumption. Hydraulic contributions to the electricity supply amount to 33 million kilowatt-hours daily, against 44 at the same period in 1948.

Following the decision to construct steam generating stations, technicians from the Ministry of Industry and Commerce have asked that supplementary steam generating plant of 300,000kW or 400,000kW be installed to guarantee production of 40 milliard kilowatt-hours at the end of 1952. As a result of a programme discussed by Electricité de France and Charbonnages de France, 260,000kW would be provided by the former and 250,000kW by the latter. Total expenditure by Electricité de France is estimated at about 20 milliard francs, of which 2 milliards will be spent in 1949.

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At the Ouasta and Mesloula lead mines in Algeria, production in 1948 rose to 17,910 tons, against 15,440 tons in 1947. A new method of exploitation is to be introduced which will enable ore formerly considered unusable to be refined.

Conditions governing the rural electrification of Morocco have just been revised and will enable the five-year plan proposed in 1946 to be realised. Construction will be assured by the State, with participation by consumers grouped in syndicates supplying between 30 and 90 per cent of the expenditure.

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From the report issued by the Chambre Syndicale des Constructeurs des Navires it would appear that the proportion of tonnage in the French fleet under ten years old is 56 per cent, against 28 per cent pre-war. Included, however, are many vessels constructed during the war by the United States, such as "Liberty" ships and "T2" petrol tankers, which are expensive to run and have a limited speed. They cannot continue to be used for long. Taking into consideration the fact that 850,000 tons of the fleet are over fifteen years old, therefore a total of 1,570,000 tons, including 720,000 tons of "Liberty" and "T2s" will need to be renewed to maintain the fleet at its present level of 3,300,000 tons. It is believed to be necessary to increase total tonnage to 4,000,000 or even 5,000,000 tons within the next ten years, so that French shipyards with their annual production capacity of 300,000 tons will be fully occupied by French Merchant Navy needs. The desirability of a Naval Statute is being pushed by French naval constructors, who point out that they must always work far ahead, and at the moment the only orders remaining to be placed are for 220,000 tons in 1949 and 120,000 tons in 1950. This means that in one or two years several building yards will be idle, and constructors demand that the whole of the 340,000 tons to be ordered by the State should be reserved for French labour. They are definitely against the Fourth Monnet Report, which states that 77,000 tons should be ordered abroad in 1949.

Notes and Memoranda

Rail and Road

Projected Tunnel in Brazil.—A preliminary scheme has been prepared for the construction of a tunnel to link Rio de Janeiro with the neighbouring town of Niteroi. Plans have been worked out for a submarine tunnel with terminal points at Calabouca, Rio, and Yragoata, Niteroi, with a length of approximately 4200m and an internal diameter of 10m. The tunnel would be constructed with two decks, the upper one carrying two-way motor traffic and the lower one equipped with double lines for electric traction. There would be ample space and facilities for pedestrians with two-way escalators at both ends.

Scrapping of Veteran Locomotives.—Three veteran locomotives of the London Midland Region of British Railways have been returned to Crewe works to be broken up. They are the ex-L.N.W.R. "Claughton" class, No. 6004, aged twenty-eight years; "Prince of Wales" class, No. 25,752, aged twenty-nine years, and "Precursor" class, No. 25,297, which was completed in 1904. These three locomotives have completed a total of 102 years of service, during which they have covered 3,245,523 miles between them. No. 25,297 was originally the L.N.W.R. "Sirocco," No. 643, and became No. 5297 in the L.M.S. stock and No. 25,297 in the 1934 renumbering. All three locomotives belong to classes which have been extensively used, 130 "Claughton" class locomotives, 246 "Prince of Wales" class and 130 "Precursor" class having been constructed.

Air and Water

Australian Aviation.—The Australian Minister of Civil Aviation, the Hon. Arthur S. Drakeford, has announced that plans are being prepared for the installation of instrument landing systems at twelve Australian airports at an estimated cost of between £A.350,000 and £A.400,000. Provision was being made for safe landings in conditions of low visibility, and the use of Ground Control Approach at busy airports was under consideration. The Minister has also announced that a formal air transport agreement with Pakistan had recently been signed. The agreement gives mutual concessions for flying across the two countries, and for embarking and disembarking passengers, mails and cargoes. Mr. Drakeford stated that the agreement was claimed to be the first real attempt to lay down in a precise form principles which would govern the capacity to be provided by the airlines of the two countries. Thus it was hoped to prevent uneconomic competition.

"Harnessing the Hills."—We were recently invited to attend a performance of a film entitled "Harnessing the Hills," which has been produced for the Scottish Office by the Central Office of Information. The film is concerned with the work of the North of Scotland Hydro-Electric Board in the construction of hydro-electric schemes to bring power to the Highlands. The manner in which the availability of cheap electric power is affecting the lives of the remote communities in the Highlands and Islands is dwelt upon, and the construction of several of the schemes is shown in progress. A general description of these works and of the economic influence which they have in Scotland, is given by the commentator as the film proceeds. "Harnessing the Hills" will be distributed non-theatrically through the C.O.I. mobile units, and will also be available on free loan from the Central Film Library, Imperial Institute, London, S.W.7, from the end of July.

Miscellanea

Scholarship Awards.—The Brush Electrical Engineering Company Scholarship, awarded annually to one of the firm's engineering student apprentices, has this year been won by Mr. G. M. Bayley. The value of the scholarship is £150 per annum, tenable at Nottingham University in the Faculty of Engineering. In view of the high standard of this year's candidates a special scholarship of £75 per annum has been awarded to Mr. J. R. French.

Herbert Akroyd Stuart Award.—The Herbert Akroyd Stuart Award, value £50, offered biennially by the Institute of Marine Engineers, under the will of the late Herbert Akroyd Stuart, for the best paper on the development of the heavy oil engine, has been awarded to Mr. John Lamb, O.B.E., M.I.Mar.E., for his paper entitled "Burning of Boiler Fuel in Diesel Engines," read on December 9, 1947, and published in the Institute's *Transactions* of February, 1948.

Iron and Steel Conference Reports.—The British Iron and Steel Research Association has recently issued reports, priced at 10s. each, on the Conference on Foundry Core-Bonding Agents, held at Ashorne Hill, Leamington Spa, on October 21 and 22, 1948, and on the Conference on the Non-Destructive Testing of Steel Castings, held at the same place on September 8, and 9, 1948. These reports are now released for public circulation and may be obtained from the Steel Castings Division B.I.S.R.A., 11, Park Lane, W.1.

"Petroleum Times" Jubilee Number.—The fiftieth anniversary of the *Petroleum Times*, which was founded as the *Petroleum Industrial and Technical Review*," and first appeared on February 18, 1899, has been celebrated by the issue of a jubilee edition. This contains nearly 200 pages of editorial matter, attractively presented with numerous illustrations, giving a general survey of the history of the oil industry during the last fifty years. The address of the *Petroleum Times* is Brettenham House, Lancaster Place, London, W.C.2, and the price of the jubilee edition is 10s.

The Next Empire Mining and Metallurgical Congress.—At the final session of the fourth Empire Mining and Metallurgical Congress on Saturday, July 16th, the decision of the Empire Council of Mining and Metallurgical Institutions to accept the invitation of the Australian Government to hold the next congress in Australia in 1953 was endorsed. The offer of the Australasian Institute of Mining and Metallurgy to organise the congress was accepted and an offer by the New Zealand Government to take part in the arrangements is to be forwarded to the Institute with full commendation.

The British Cast Iron Research Association.—It is announced that as from August, 1949, the *Journal of Research and Development* issued by the B.C.I.R.A. will cease to be a confidential publication and will be generally available to non-members of the Association on subscription terms. This decision has been based chiefly on the large increase in membership of the Association. It is now felt that it is neither practicable nor desirable to maintain the confidential status of a journal which is so widely circulated. The *Journal* carries reports of complete investigations conducted by the Association's research and development staffs, together with papers presented at the Association's conferences. The *Journal* is published six times a year, and the annual subscription is £2 or eight dollars, post free.

The Use and Design of Curved Safety Glass.—A technical bulletin (No. 3/49) with the above title, has been prepared by the Triplex Safety Glass Company, Ltd. The bulletin, which is amply illustrated, provides detailed information on the types of curvature which lend themselves to economical volume production, combined with satisfactory optical qualities. After a summary of the advantages of curved safety glass, the manufacturing processes, and the types of curvature available, the bulletin devotes considerable attention to the practicability of various types of curve with relation to price and optical qualities. It is pointed out that curved safety glass has been developed so recently that no specification has yet been issued to cover it. It is not, therefore, possible at present to apply the B.S.I. mark to it, but nevertheless, the safety properties of curved Triplex safety glass are said to be fully equal to those of flat Triplex. Copies of the bulletin are available upon application to the Triplex Safety Glass Company, Ltd., 1, Albemarle Street, London, W.1 (telephone REGent 8171).

Illuminating Engineering Code.—The Illuminating Engineering Society's "Code for the Lighting of Building Interiors" (known more briefly as "The I.E.S. Code") was first published as "Recommended Values of Illumination," in 1935. The code is a set of rules and recommendations for good interior lighting and is intended for the reference of those concerned with lighting practice and as a guide to the user in stating his lighting requirements. The recommended values of illumination are in general lower than the levels recommended in some other countries, as in this country we are not yet satisfied that there is any advantage to be gained by raising levels above a certain limit. A significant change in this new edition is the printing of the illumination charts in colour on a graded background, so that the effect of difference in contrast between objects of various sizes and background and the necessity for higher levels of illumination under conditions of poor contrast are effectively shown. A useful addition is a list of British Standard specifications on illumination and lighting fittings. Copies of the code may be obtained from the Society at 32, Victoria Street, London, S.W.1, price 2s. 6d.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Supervising Electrical Engineers

Tues., Aug. 9th.—S.W. LONDON BRANCH: Compton Hall, Compton Road, Wimbledon, "Must We Starve," L. E. C. Hughes, 8.15 p.m.——WEST LONDON BRANCH: Town Hall, King Street, Hammersmith, "The Technicalities and Application of Cold Cathode Lighting." E. A. Langsdon, 7.30 p.m.

Engineering and Marine Exhibition

Thurs., Aug. 25th, to Sat., Sept. 10th.—Olympia, London.

Institute of Road Transport Engineers

Thurs., Aug. 18th.—NORTH-WEST CENTRE: Visit to the works of Leyland Motors, Ltd., Leyland, Lancs, 10.30 a.m.

Personal and Business

FOSTER WHEELER, Ltd., states that Mr. G. A. Brooke and Mr. William Sampson have been appointed directors.

BROOK MOTORS, Ltd., announces the appointment of Mr. G. H. Brook, A.M.I. Mech. E., as deputy sales manager.

MR. A. F. HARPER has been elected to the board of Crabtree Electrical Industries, Ltd., in place of Mr. J. F. Harper, who has resigned.

THE ENGLISH ELECTRIC COMPANY, Ltd., announces the appointment of Mr. A. V. Wilkin as general manager of its newly formed diesel engine division, with headquarters at Rugby.

THE GENERAL ELECTRIC COMPANY, Ltd., states that Mr. A. J. Emery, B.Sc., M.I.E.E., has been appointed manager of the north-western area, in succession to Mr. A. G. Hawkins, who has retired.

MR. K. L. CLUCAS has been appointed Manchester branch engineer of the General Electric Company, Ltd., in succession to Mr. C. W. Myring, who is joining the company's South African organisation.

MR. J. E. KEAL, A.M.I. Mech. E., has relinquished his position as assistant works director with Dening and Co. (1937), Ltd., to take up an appointment as consultant with Associated Industrial Consultants, Ltd.

BURTON, GRIFFITHS AND CO., Ltd., the distributing organisation for B.S.A. Tools, Ltd., announces that the telephone number of the Small Tools Division of B.S.A. Tools, Ltd., and its own telephone number have been changed to Birmingham Victoria 2351/9.

THE RAPID MAGNETTING MACHINE COMPANY, Ltd., Birmingham, announces that it has completed an agreement with Dings Magnetic Separator Company, Milwaukee, U.S.A., for the exchange of technical information, and for the manufacture in this country of certain products hitherto made exclusively in the U.S.A.

KELVIN AND HUGHES (INDUSTRIAL), Ltd., has been formed to deal with the sales and servicing of the industrial instruments hitherto sold under the names of Kelvin, Bottomley and Baird, Ltd., and Henry Hughes and Son, Ltd. Kelvin and Hughes, Ltd., which was formed in 1947, now operates as the manufacturing company covering all the production and engineering activities of Kelvin, Bottomley and Baird, Ltd., and Henry Hughes and Son, Ltd., at their Hillington, Barkingside and Basingstoke factories. Mr. F. A. King, who has been associated with Kelvin, Bottomley and Baird, Ltd., for forty years, has retired from the position of joint managing director of Kelvin and Hughes, Ltd., but will continue to serve as a consulting director. Mr. G. B. G. Potter has become sole managing director. Mr. W. R. L. Kent, A.M.I. Mech. E., A.M.I.E.E., has been appointed a director and general sales manager of Kelvin and Hughes (Industrial), Ltd., operating from the main sales office at 2, Caxton Street, London, S.W.1. Another sales office is maintained at 110, Bothwell Street, Glasgow, C.2.

INTERNATIONAL HIGH TENSION CONFERENCE.—The thirteenth meeting of the International High Tension Conference (C.I.G.R.E.) will be held at the Fondation Berthelot, 28, rue Saint Dominique, Paris, from Thursday, June 29th, to Saturday, July 8th, 1950. The opening ceremony will take place on the morning of Thursday, June 29th, and the technical discussions will commence in the afternoon. The address of the Secretary of the British National Committee, C.I.G.R.E., is Thorncroft Manor, Dorking Road, Leatherhead, Surrey.

Technical Reports

Atlas of Isothermal Transformation Diagrams. By the Thermal Treatment Sub-Committee of the British Iron and Steel Research Association. Special Report No. 40. The Iron and Steel Institute, 4, Grosvenor Gardens, London, S.W.1. Price 25s. (members 15s.).—Control over the results of heat-treatment of steel has been extended in recent years by the study of "S-curves" or isothermal transformation diagrams. These curves show what happens to the structure of a particular steel when it is held at a certain temperature after rapid cooling from above the critical temperature, which is usually in the range of 700 deg. to 800 deg. Cent. They show the varying effects on the structure of holding or "soaking" at various temperatures for different periods of time. Below a temperature known as the MS point the martensitic transformation is instantaneous, although the degree of transformation can be controlled by suitable choice of quenching temperature. All transformation temperatures vary according to the composition of the steel.

For example, if a 3 per cent nickel steel (En 21) is quickly cooled from above 700 deg. Cent. to about 400 deg. Cent. and held at that temperature, transformation of the austenite begins after about 15 seconds, and the amount transformed is respectively 10, 50, 90 and 100 per cent after about 30, 50, 100 and 400 seconds. But if the soaking temperature is 350 deg. Cent. transformation begins after 35 seconds, and the corresponding periods for 10, 50, 90 and 100 per cent are about 75, 150, 300 and 900 seconds. The MS point for this steel is 310 deg. Cent. For this particular steel numbers of detailed observations have been made at thirteen temperatures, ranging between 350 deg. and 700 deg. Cent. The S-curves plotted from these observations correspond to the five stages of transformation mentioned above. They show the time of "soaking" required at each temperature on the curves for each stage to be reached.

The report contains the first authoritative published collection of S-curves for the main types of wrought steel in current use in this country. The data has been collected by the Thermal Treatment Sub-Committee of the British Iron and Steel Research Association and represent the results of collaborative work by a number of industrial laboratories. The Atlas contains S-curves for 24 En steels of the British Standards Institution's En series detailed in B.S. 970: En 12 to 19, 21, 23 to 26, 28, 30, 31, 40, 42, 44, 45, 47, 56, 100 and 110. Each diagram is accompanied by a data sheet which records the compositions of the steel, its previous treatment, the hardness of the transformation products obtained at various temperatures, photomicrographs, and general comments which include reference to the hardenability of the steel.

The text of the report outlines the principles underlying the construction of isothermal transformation diagrams and the experimental procedure used for the determination of the curves, and discusses the results and their application. Furthermore, the report points out that it is the main purpose of isothermal transformation diagrams to provide a basis for appreciating the behaviour of steels when quenched in sections which do not harden completely, rather than to give data for the design of heat-treatment schedules.

Corrosion of Iron and Steel by Industrial Waters and its Prevention. By the Industrial Waters (Corrosion) Sub-Committee of the British Iron and Steel Research Association. Special Report No. 41. The Iron and Steel Institute, 4, Grosvenor Gardens, London, S.W.1. Price 5s. (members 3s. 9d.).—This booklet of fifty-six pages contains an introductory section describing the general theory and mechanism of corrosion, and the different types of corrosion which may occur, followed by three sections dealing respectively with the causes, occurrence and prevention of corrosion in industrial plant.

The section concerned with the causes of corrosion discusses the various factors connected with the water, the metal itself, and external conditions, which contribute to the corrosion of iron and steel. The next section contains a description of the occurrence of corrosion in industrial plants, such as water mains, steam boilers, heating, cooling and refrigerating systems and so on; most of the twenty illustrations in the book refer to this section. The last section outlines methods of water treatment and the use of corrosion inhibitors, to prevent the incidence of corrosion, as well as prevention by suitable choice of material, metallic and non-metallic protective coatings, cathodic protection and mechanical and chemical descaling. The report also contains a short bibliography and a list of nearly 100 references to papers in the English language.

Report on the Bessemer Process. By a Sub-Committee of the Steel Practice Committee of the British Iron and Steel Research Association. Special Report No. 42. The Iron and Steel Institute, 4, Grosvenor Gardens, London, S.W.1. Price 25s. (members 15s.).—The report is in three main parts, which deal respectively with British, foreign and future Bessemer practice. There are also eight appendices, the first six describing in detail particular plants and methods. The seventh appendix consists of three and a half pages of abstracts of publications on the subject since 1946. (The period 1925 to 1946 is already covered by Bibliography No. 14, published by the Iron and Steel Institute in 1947.)

The first part of the report, which deals with British Bessemer practice, consists of four sections covering basic, acid, surface-blown and multiplexing processes. Foreign Bessemer practice is described in the next part, which outlines the methods in use in Sweden, Germany and the United States. The Swedish section is based on an investigation made in late 1946, and the German section on two investigations (one by a German) in 1946 and 1947; the section on the United States is based on an investigation made in 1932 and supplemented with a note on present-day practice in the U.S.A., in which it is noted that since 1932 "there has been no major change."

The last part, which is concerned with future Bessemer practice, has two sections. The first of these contains suggestions for future developments, and considers that three recent developments on the Continent merit investigation in this country, namely, oxygen enrichment of the blast; the modified, large side-blown converter, and double-blowing the metal. It is also considered that "catching carbon" might be a fruitful subject for research, which might extend the scope of the basic Bessemer should the occasion arise. For a somewhat similar reason it is suggested that investigations should be made by "B.I.S.R.A." into the manufacture in Bessemer steel of products for which it is not usually employed. The second section consists of a report on the use of oxygen-enriched air in the surface-blown converter at Catton and Co., Ltd.'s works in Leeds.

The Sub-Committee was composed of working Siemens and Bessemer steelmakers. Their report is based on visits to Corby, Ebbw Vale and Workington, as well as to two side-blown converter plants, where plant and methods were examined and discussions were held with the works staff.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1.

MOWER PARTS

No. 1562: 1949. This is a further standard in the series in course of preparation for agricultural machinery and implements. It gives details of the construction and materials, and dimensions of knife sections, knife backs, fingers and rivets. Three types of knife sections are provided for: two-hole flush-back sections, and two and three-hole overhanging sections. The standard has been prepared with the long-term object of reducing the number of types of mower knife sections and it is hoped that manufacturers will make use of the standardised sections as soon as possible. It is pointed out in the standard that the tolerance on the width and thickness of the sections will probably be reduced at an early date, when the material position has become easier. Price 2s.

REELS AND WOODEN DRUMS FOR BARE WIRES

No. 1559: 1949. The particulars for reels have been based on the sizes in the recently issued British Standard (B.S. 1489) for reels for covered, solid, round, electrical winding wire. As the requirements for bare wire are not necessarily as stringent as those for covered wire, no tolerances are specified except for bore diameter. Particulars are given in the standard for the sizes and construction of wooden drums for bare wire, stranded conductors, trolley and contact wire, and a diagram gives the nomenclature of the various component parts of the drums. Price 2s.

ENGINEERING FIRMS' APPRENTICE SCHEMES.—We have received from Guy Motors, Ltd., an illustrated booklet describing its apprenticeship scheme. Apprentices commence a five-year course at the age of sixteen or seventeen, and obtain practical experience in the various workshops, technical departments and offices, whilst simultaneously studying for the Ordinary and Higher National Certificates. We have also received from Raleigh Industries, Ltd., Nottingham, an illustrated booklet containing details of a new five-year apprenticeship scheme, which will shortly be issued to all youths joining the company.

A Seven-Day Journal

The Engineering and Marine Exhibition, 1949

THE seventeenth Engineering and Marine Exhibition, which will be held at Olympia, London, from Thursday, August 25, to Saturday, September 10, 1949, will be the largest since this series of exhibitions was inaugurated in 1906. All three Olympia halls will be used to show the latest products of more than 500 firms in the engineering industry to buyers from home and abroad. The organisers, F. W. Bridges and Sons, Ltd., have decided that the theme of the exhibition this year shall be "Production efficiency is the road to national recovery," and to this end are making an interesting experiment to assist in the national production drive. Organised parties of employees from industrial firms are being invited to attend the exhibition free of charge to inspect the work of their own and other firms side by side. It is hoped by this means to stimulate a greater interest in operatives' work when they have seen the finished products, to which they have contributed their efforts, actually displayed for inspection to buyers from all parts of the world. Practically every large manufacturer of general engineering, marine and welding equipment will be represented at the exhibition, and it is anticipated that it will be possible for most to offer better delivery dates than in 1947, the occasion of the last exhibition, when heavy post-war demands and the change-over from war to peacetime production caused many delays. This year, as on previous occasions, THE ENGINEER will have its familiar stand near the centre of the Grand Hall and will be at the service of its many friends in industry.

A Wool Textile Fuel Efficiency Conference

IT is announced that a Wool Textile Fuel Efficiency Conference is to be held in the Huddersfield Town Hall on Tuesday and Wednesday, September 20 and 21, 1949, under the joint auspices of the Ministry of Fuel and Power and the Wool Textile Delegation. The principal speaker at the opening ceremony will be Mr. Alfred Robins, the Parliamentary Secretary of the Ministry of Fuel and Power. An exhibition of fuel efficiency equipment will be displayed on both days in the Corporation Street entrance hall of the Town Hall. Mr. Fred Haigh, the Chairman of the Wool Textile Delegation, will preside at the opening of the Conference at 10 a.m. on Tuesday, September 20th. In the first session the Chairman will be Mr. Leslie G. Wilson, Vice-Chairman of the East and West Ridings Regional Board for Industry. The first paper will be read by Mr. W. W. Spooner, M.A., M.I.C.E., the managing director of the Spooner Drying and Engineering Company, Ltd., who will deal with "Drying Processes in the Wool Textile Industry." He will be followed by Mr. F. Buckingham, B.Sc., A.C.G.I., M.Cons.E., A.I.M.E.E., A.M.I. Mech.E., partner in the firm of Messrs. Cramp and Frith, who will speak on "Power Process Combinations." In the second session the Chairman will be Dr. W. E. Scott, M.Sc., F.R.I.C., the Principal of Huddersfield Technical School. A paper on "Efficient Steam Utilisation in the Piece Drying and Finishing Trade" will be read by Mr. C. T. Wade, Director of the Leeds and District Dyers' and Finishers' Association. Mr. R. Adams, B.Sc., assistant chief engineer of Woolcombers, Ltd., will follow with a paper on "Process Steam Economy in the Woolcombing and Scouring Sections of the Industry." On Wednesday, September 21st, at the third session, the chair will be taken by Mr. W. A. Wordley, M.Inst.F., chief power plant engineer of Bradford Dyers' Association, Ltd. The first paper will be read by Dr. E. G. Ritchie, A.M.I.C.E., A.M.I.Mech.E., Director of the B.C.U.R.A. laboratories, on "Combustion Problems and Modern Boiler-House Practice," with reference to internally fired boilers. It will be followed by another paper by Mr. H. Matthews, A.M.I.Mech.E., technical director of Crofts (Engineers), Ltd., on "Electrical and Mechanical Power Application Problems." In the fourth session the chair will be taken by Major G. H. Kitson, Chairman of the North-Eastern Regional Fuel Efficiency Committee, at which Mr. M. Brookes, A.M.I. Mech.E., chief engineer of Lister and Co., Ltd., will read a paper on "Instrumentation Measurements and the Use of Records." Following the presentation of this final paper, Mr. S. J. Eardley, A.M.I.Mech.E., Regional Fuel Engineer, the Ministry of Fuel and Power, will sum up the discussion of all sessions. Applications for tickets of admission should be made to the Secretary of the Fuel Efficiency Committee, the Ministry of Fuel and Power, Century House, Leeds, 1.

New Zealand Shipping Company's Motor Liner "Rangitoto"

AFTER successful trials, the new motor liner "Rangitoto," built by Vickers-Armstrongs, Ltd., at Walker-on-Tyne, for the service of the New Zealand Shipping Company, Ltd., came round last weekend from the Clyde to the Thames, in preparation for her maiden voyage for Wellington, New Zealand, on Monday, August 25th. She is a twin-screw passenger and refrigerated cargo vessel of 21,809 gross tons, with an overall length of 609ft, a breadth moulded of 78ft, and a depth moulded of 53ft to "C" deck. The passenger accommodation is of a very high order, and is arranged for a one-class ship, the public rooms being available for all passengers. The main propelling machinery consists of a twin-screw arrangement of Vickers-Doxford opposed-piston oil engines, designed to develop a total of 13,900 s.h.p. continuously when running at a speed of 114 r.p.m., with a mean indicated pressure of about 85 lb per square inch, for an average service speed of 17 knots. The machinery is designed to develop a total of 16,000 b.h.p. at 120 r.p.m., and has therefore an ample reserve of power to meet any normal service demand. The bore of the main cylinders is 725mm, with a combined stroke of 2250mm. The stroke of the upper piston is 950mm and that of the lower piston 1300mm. Each engine has three lever-driven, double-acting scavenge pumps. The engines follow normal Doxford practice, except for some special requirements to meet the owner's specification. The electrical power needed in the ship for domestic and engine-room machinery and refrigerating machinery is supplied by four Ruston and Hornsby pressure-charged oil engines, driving Sunderland Forge 500-kW dynamos. The steam requirements for galleys and other services are met by the installation of two Nelvin oil-fired boilers of the thimble-tube pattern and two Nelvin exhaust gas boilers, which are coupled to the port and starboard main engines. The oil-fired boilers each have an evaporation of 6500 lb per hour at 120 lb pressure. Each exhaust gas boiler has a duty of 4000 lb evaporation under service conditions.

Highway Engineering Appointments

AN announcement has recently been made by the Ministry of Transport concerning the following highway engineering appointments, which have been made by Mr. Alfred Barnes, the Minister of Transport:—Mr. R. J. Samuel B.Sc. (Eng.), M.I.C.E., has been appointed Deputy Chief Engineer (Civil Engineering), in succession to Mr. E. B. Hugh-Jones, B.Sc., M.I.C.E., who was recently appointed Chief Engineer on the retirement of Mr. H. E. Aldington. Mr. A. E. N. Taylor, B.Sc. (Eng.), A.M.I.C.E., who for the past three years has been Assistant Chief Engineer in charge of the traffic and mechanical engineering branch at headquarters, has been appointed to fill a new post of Deputy Chief Engineer (Traffic and Mechanical Engineering). Mr. H. S. Keep, B.Sc. (Eng.), M.I.C.E., A.C.G.I., becomes Assistant Chief Engineer at headquarters. It is also announced that Mr. C. E. Hollinghurst, M.Eng., A.M.I.C.E., has been appointed to the position of Divisional Road Engineer for the Metropolitan Division in place of Mr. G. H. Hargreaves, B.Sc., M.I.C.E., who becomes an Assistant Chief Engineer at headquarters in place of Mr. Hollinghurst.

A Jet Aircraft Endurance Record

ON Sunday last, August 7th, a new endurance record for a jet-powered aircraft was established by Mr. Patrick Hornidge, who, while flying in a Gloster Meteor, remained in the air for just over twelve hours. The flight, which was arranged and carried out by Flight Refuelling, Ltd., was officially observed by the Royal Aero Club. The aircraft, the Gloster Meteor, and a Lancaster carrying the paraffin fuel took off from an airfield at Tarrant, Rushton, in Dorset, at 5.20 in the early morning, and landed at 5.23 the same evening, having been airborne for twelve hours and three minutes. The refuelling was carried out by means of a pipe-line trailed from the Lancaster aircraft, which terminated in a large white painted cone, the wind stream serving to keep the cone in a relatively fixed position. On the nose of the Meteor there was a long tubular probe, which was inserted in the cone as the aircraft flew towards the Lancaster a little below and behind it. When the probe entered the cone a joint was made, and when tight a valve was opened and the fuel flowed from the tanks in the fuelling aircraft into the fuel tank of the Gloster Meteor. When this tank had been filled the supply of fuel was automatically cut off and the joint again broken. During the day, Mr. Hornidge's machine was refuelled no less than ten times, a total of about 2352 gallons of paraffin being transferred. During the flight the Meteor covered some 3600 miles along the South Coast at a speed of about 300 m.p.h. The Lancaster carried a full crew with radar operators and throughout the flight contact with the Gloster Meteor was unbroken. The Lancaster had, however, to land twice to take in new supplies of fuel.

Launch of Destroyer H.M.S. "Daring"

THE launch of the destroyer "Daring" from the Wallsend shipyard of Swan Hunter and Wigham Richardson, Ltd., on Wednesday, August 10th, was of interest as the "Daring" is the name ship for a new class of large destroyers. A sister ship, the "Decoy," was launched by Yarrow and Co., Ltd., at Scotstoun, on March 29th, and that event was recorded in a Journal note of April 8th. The naming ceremony was performed at Wallsend by Mrs. Leonard Hall, the wife of Doctor The Hon. Leonard Hall, and the daugher-in-law of Viscount Hall, the First Lord of the Admiralty. The "Daring" is of all-welded hull construction, and in general her design incorporates new features based upon the lessons learned in the second World War. She has an overall length of 390ft, and a beam of 43ft. Her armament comprises six 4·5in guns and six smaller guns, while two pentad torpedo tubes are carried. Her main propelling machinery comprises twin-screw Parsons geared steam turbines constructed by Wallsend Slipway and Engineering Company, Ltd., taking steam from high-duty Admiralty pattern water-tube boilers. In the design of the "Daring" class of destroyers every effort has been made to ensure the comfort of the ship's company, great care having been bestowed in the design stages to the spaces available for accommodation. There will be electrical cooking apparatus in the galleys, and an electric laundry. Other items include modern bathroom facilities for the ship's company, and centralised arrangements in the preparation of food, with the maximum of labour-saving devices for cleaning ship. Six further ships of the "Daring" class are under construction on the Clyde and at Southampton and Cowes, making a total of eight of the new "D" class destroyers.

Construction of the Castelo-do-Bode Dam, Portugal

No. III—(*Continued from page 145, August 5th*)

Cement Handling Plant

THE bulk cement plant is situated adjacent to the main mixing station. Cement is carried by road transport from Santa Cita and is discharged into a steel hopper of 50 tons capacity. It is reclaimed from this hopper by a draglink type conveyor of 60 tons per hour capacity, driven by a 4 h.p. squirrel-cage motor. The hopper has four discharge openings, each fitted with a slide type discharge gate for emergency use.

The conveyor feeds cement into No. 1 activator hopper; both hopper and activator container have a capacity of 4 tons. The activator, a welded steel pear-shaped container, is gravity fed through an air-operated gate. When the activator is full an electric bulb automatically lights on the control panel and the operator, closing the gate, admits compressed air into the activator container, causing the cement to become fluid. The air carries the cement through the discharge pipe, fully evacuating the container.

The airborne cement is thus conveyed to the six 500-ton steel silos through 4in bore piping. These silos may be seen in the illustrations reproduced herewith. Two-way valves are fitted so that any one silo can be filled. A warning light appears at the activator controls when a silo is full.

The six cement silos are fabricated in steel plate, stiffened with rolled steel sections. Each one comprises a cylinder 22ft in diameter and 26ft deep, with a steep-sided, self-cleaning conical hopper fitted with anti-arching high-pressure air jets. Weather-proof steel roof plates are fitted with a large ventilator, allowing the exhaust air to escape. The supporting structures each consist of four 12in by 12in broad-flanged, rolled steel joists as main legs, with angle bracing members. A steel-frame walkway is provided above the silos with an access ladder to ground level.

Each silo is fitted with a rotary cement valve to control the feed, and with a slide gate for use in emergency. Two draglink conveyors reclaim the cement, in the one case from two silos and in the other from the remaining four silos. They are driven by 4 h.p. and 8 h.p. squirrel-cage motors respectively. Both conveyors deliver into the hopper of No. 2 activator. The feed is automatically stopped when the hopper is filled, No. 2 activator is a replica of No. 1 and delivers cement through 4in bore pipes, either to the lower plant or the main mixing plant. Two-way valves are fitted to divert the flow as required.

Compressed air for the operation of both activators and the silo anti-arching jets is supplied by a Broom and Wade No. 251, three-cylinder air compressor, delivering 500 cubic feet per minute at 100 lb per square inch. The compressor is driven by a 112 h.p. slip-ring motor and is fitted with an after-cooler. A receiver of 125 cubic feet capacity is situated adjacent to each activator.

Main Mixing Station

The main mixing station comprises two plants, designed to mix 120 cubic metres per hour, the maximum stone size being that passing an 8in mesh. Each plant contains an eight-compartment bin of 810 tons capacity, divided to contain 188 tons each of 100–200mm and 50–100mm aggregates, and 75 tons each of 25–50mm, 10–25mm, 2–10mm, 0–2mm and fines. In addition, a central circular compartment contains 59 tons of cement.

Each bin is fabricated in mild steel plate, stiffened with rolled steel sections, and is cylindrical in shape, being 27ft in diameter and 26ft deep, with a hopper portion. The compartments are formed by mild steel bulkheads, which radiate from the cement compartment. A roof plate with a ventilator is fitted to the cement compartment. The feed of aggregates to the plant is visible from the ropeway unloading platform, and a warning light appears at No. 2 activator controls when the cement compartment is filled.

Each supporting structure is made up of six 20in by 12in broad-flanged joists as main legs, with rolled steel bracing members. The bins and structures are of bolted construction to facilitate easy dismantling and re-erection elsewhere.

Electro-pneumatically operated bin gates at the bin bottom feed the eight weigh hoppers which are suspended on separate weighing beams. The 50–100mm and 100–200mm stone is controlled by undercut gates and the other sizes by gates of the clamshell type. The cement is controlled by a rotary valve. The weigh hoppers are of robust mild steel construction and are fitted with pneumatically operated hinged discharge doors for the aggregates and a further rotary valve for the cement. The water weigher has feed valves and a pneumatically controlled discharge valve.

Weighing and discharge of all aggregates, cement and water is carried out by one man at the central panel by push-button electric control. Push-buttons are provided for operating the bin gates and water feed valves. The operation of each push-button causes an electro-pneumatic valve to actuate an auxiliary pneumatic valve, which passes compressed air to the pneumatic rams controlling the various bin gates.

The bin gates and water feed valves close automatically when an adjustable amount below correct weight is indicated. Mercury switches attached to the weigh beams cause the electro-pneumatic valves to actuate reversing valves, which reverse the pneumatic rams. The weigh dials are conveniently grouped immediately in front of the operator.

When correct weight is obtained on all weigh dials an electric current is made to the discharge push button, thus permitting discharge of the contents of all the weighers, provided first that the breeches chute deflector gate is set correctly, and secondly that the correct mixer is in position to receive the materials.

The weigher discharge gates are controlled in a similar manner through electro-pneumatic valves, an adjustable time relay delaying the discharge of the large-size stone. A further adjustable time relay is provided in the water weigher circuit to allow discharge to be simultaneous with the other constituents.

All aggregate and cement weighers discharge into a steel receiving hopper, which passes the materials into a bifurcated chute in which is fitted a deflector gate. This gate is operated by a pneumatic ram to direct the flow to one or other of the mixers. The weighed water is directed into the appropriate mixer through a two-way valve synchronised to the deflector gate shaft.

Electrical interlocks prevent discharge of the weigh hoppers or water weigher except when all materials are correctly weighed and when one or both concrete mixers are in the charging position. If only one mixer is so positioned, discharge is prevented unless the deflector gate in the bifurcated chute is in the correct position to feed this mixer. As some sizes of stone may not be required for a particular mix, the weigher in question can be cut out of the system by operating isolating switches on the control panel.

It was originally intended to bring fines from Tramagal by road and discharge the lorries into a concrete hopper and reclaiming

MAIN MIXING STATION

plant adjacent to the main mixer. However, the sand, as reclaimed from the river, has proved to have sufficient fines, so that this part of the plant has not been erected.

The main concrete mixing station and bulk cement plant were supplied by Blaw-Knox, Ltd., London.

Concrete Mixers

The concrete mixers for the main mixing plant were supplied by Stothert and Pitt, Ltd., of Bath, Somerset. Four double-cone type tilting mixers, each driven by a 40 b.h.p. high-torque electric motor and each delivering 1·6 cubic metres (or 2 cubic yards) of concrete per batch were supplied.

As each pair of mixers receive their weighed batches from the common steel receiving hopper mounted centrally above them, and after mixing discharge into a centrally disposed concrete receiving hopper, it was necessary that one mixer in each pair should be of opposite hand construction. It was also necessary to design both machines to permit feed and discharge through the same drum openings. Hinged chutes of special design were used for this purpose. These hinged chutes conduct the weighed batch into the mixer drums and are then automatically withdrawn as each mixer is tilted to discharge mixed concrete.

The mixers are of robust construction, since they must withstand the heavy wear and tear imposed by the use of 200mm (8in) aggregates. Each mixing drum is fitted with renewable $\frac{3}{8}$in steel liners and mixing blades constructed in $\frac{1}{2}$in rolled steel plate. The machines are driven through machine-cut spur and bevel gearing of cast and high-tensile steel, the tilting mechanism being operated through reversing clutches.

The two concrete mixers discharge into a common steel receiving hopper of 11 cubic yards capacity, which is supported from the main concrete foundations. This hopper is provided with a large discharge opening fitted with a Blaw-Knox roller gate. The gate is operated by a pneumatic ram controlled through auxiliary and reversing valves by a hand control valve at ground level. The compressed air is provided by four Broom and Wade N.5 air compressors, each with a capacity of 33 cubic feet per minute and driven by $7\frac{1}{2}$ h.p. squirrel-cage motors.

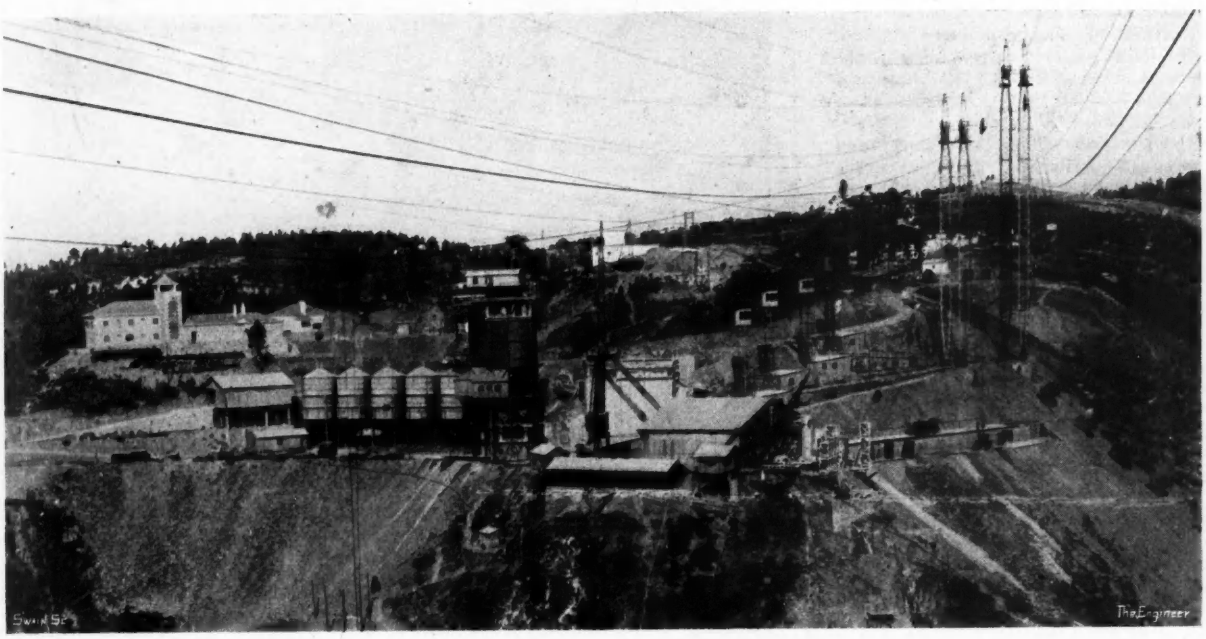
Transporting Concrete

The concrete is discharged directly from the hopper into diesel-engined "shuttle" dumpers, built by Aveling-Barford, Ltd., of Grantham. The use of this type of vehicle saves time, in particular on short trips, where the reversible driving position and dual controls enable the machine to travel and return between loading and tipping points without turning.

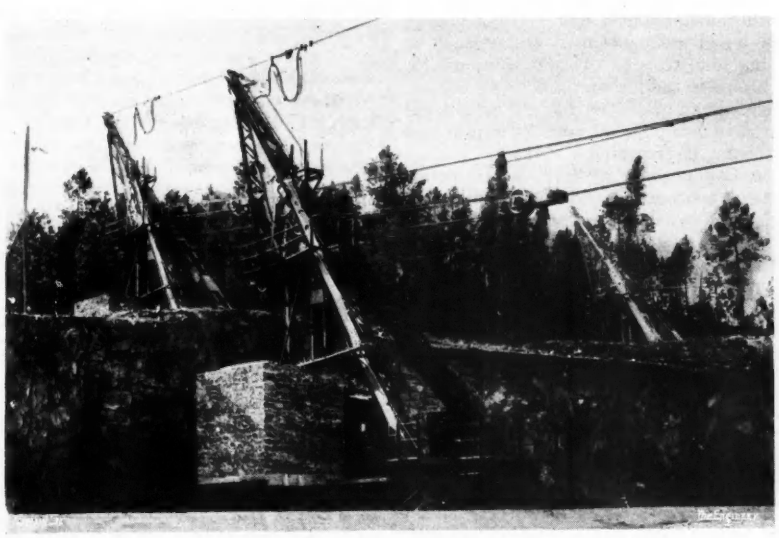
In order to permit the transport of two complete mixer loads of concrete at a time to the cableway skips, the original dumper bodies were fitted with flare plates around the rim and with an automatic tail gate, which opened instantaneously as the hopper tipped. Because the width of the dumper body was greater than that of the cableway skip, the concrete was discharged to the skips through a funnel-shaped chute. An alternative type of body which was fitted subsequently, does not tip, but has a door which is opened automatically by a trip lever. The trip lever hits a ramp as the vehicle approaches its discharge point, thus permitting direct discharge to the cableway skips, which are not removed from their respective hooks.

Concrete Placing Cableways

Electrically driven radial travelling aerial cableways were installed for placing concrete for the dam and for handling shuttering and other miscellaneous equipment. The cableways are each designed to hoist, transport and deposit a Blaw-Knox single-line bottom-discharge skip containing 4 cubic yards of concrete, at any required point. The maximum load on the hook of each cableway is 10 tons, made up of the weight of the skip and slings and the contents of the skip. The span of the cableways is 1660ft and the tail



Main Mixing Station and Cableway Headmasts



Cableway Tailmasts

carriages can be traversed electrically through a maximum distance of 450ft, this distance being equivalent to an angle of approximately 16 deg. about the head masts. Two of the fixed masts are 190ft high and two are 150ft high; they are guyed at the back and sides to steelwork embedded in masonry and concrete. The top of each mast is arranged to swivel to accommodate the movements of the corresponding tail carriage. The tail carriages are 36ft in height and are mounted on four four-wheeled bogies travelling on tracks set at 25ft centres. The bogies are arranged to compensate for variation in rail levels, and the levels of front and rear tracks. The tail carriages of two cableways travel on one track and the other two tail carriages on a second track. The depth of lift of hook below the crest of the dam is 338ft.

Illustrations of the head masts and tail masts of these cableways are shown in the illustrations on page 163. The four cableways cover the whole of the construction work of the dam.

The load carriage wheels are compensated to give equal distribution of weight on the track cable, and the track wheels are fitted with ball bearings, as are all the pulleys for the cableway running ropes. The hoisting and lowering speeds with full load are 250ft per minute and the travelling speed on the load carriage in either direction with full load is 1000ft per minute. On each cableway the electric motor for operating these motions is of 250 b.h.p. The tail carriages travel at 25ft per minute and are each driven by a 45 b.h.p. motor.

The cableway winding gears are placed near the respective head masts. The winch drums are 5ft 1¼in diameter and are driven from the motors by machine-cut gearing, the first reduction gear being enclosed in an oil-retaining case fitted with ball bearings. Both motions on each cableway are fitted with automatic "thrustor"-operated brakes. The winding gears are enclosed in timber houses.

The control cabin for each machine is placed in an elevated position on a steel tower 50ft above ground level. All controls are arranged for easy operation at the front of the cabin, and the windows are arranged to give the driver a good view of the work.

Indicators are provided on each machine to give the approximate position of the load in both the horizontal and vertical planes, and a telephone equipment is installed on each machine to give two-way communication between the driver and a signalman. The signalman positions himself where the concrete is being placed, and he is provided with breast instruments. "Walkie-talkie" radio communication sets have been supplied for general use, and telephone communication is also provided between the driver and the tail carriage. This carriage is also controlled from the driver's cabin, and all the motions are controlled by one man through the medium of contactor panels with master control drums.

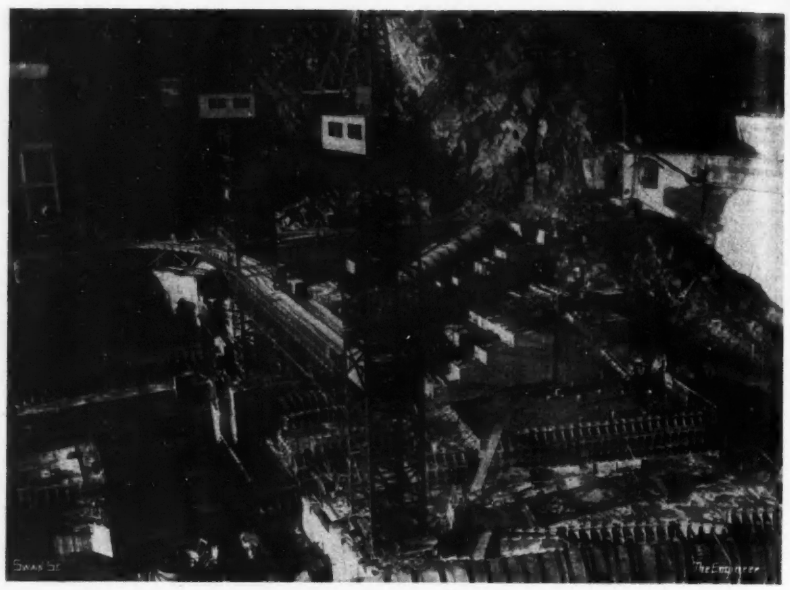
The hoisting and travelling controls are arranged to give slow speeds by electric control, and the full load can be lowered at varying speeds without recourse to mechanical brakes. In the event of over-speed or failure of power supply, or on returning the control handle to the "off" position, all brakes are applied. The power to the motor in each tail carriage is transmitted by a power cable suspended between the head and tail supports.

Limit switches are fitted on the tail carriage of each cableway to bring it to rest at the ends of the tracks and to prevent the carriages fouling one another. After the erection of all cableways had been completed the machines were tested with 25 per cent overload. The cableways and rail tracks were designed, manufactured and erected by John M. Henderson and Co., Ltd., engineers, Aberdeen. The electric motors were supplied by Metropolitan-Vickers Electrical Company, Ltd., Manchester, and the control gear by Igranic Electric Company, Ltd., Bedford.

Subsidiary Mixing Station

In addition to the main concrete mixing station there is a lower mixing plant, to which reference has previously been made. This plant was installed to supply concrete to the cofferdams and to the lower lifts of the central section of the dam, in the early stages before the cableways were in operation. It will also supply the greater part of the concrete in the power-house. The aggregate is transported to this mixing station by road from the washing and screening plant, and the cement comes from the bulk cement plant through a 4in pipe-line. The two concrete mixers, each delivering 1·6 cubic metres (or 2 cubic yards) of concrete per batch, were supplied by Stothert and Pitt, Ltd.

These concrete mixers differ from those installed in the main mixing plant only in that they are equipped with standard batch cleansing hoppers and feed chutes, and are consequently fed and discharged through opposite drum openings.



Placing Concrete from Lower Mixing Station

Derricks

Two 7-ton, three-motor electric mono-tower cranes are used to handle the concrete from the lower mixing plant and to place in position the turbine ducts and other heavy parts. Each crane has a jib 135ft long and is capable of lifting 7 tons at 115ft radius or 4 tons at 130ft radius.

These cranes, being of the three-motor type, are fairly fast operating and are capable of hoisting speeds of 80ft per minute and 150ft per minute respectively, when lifting loads of 7 tons and 3 tons. The hoisting motor has a power of 60 b.h.p. Similarly, with a 7-ton load the 30 b.h.p. derricking drive can work at 50ft per minute and the 20 b.h.p. slewing drive at 500ft per minute. There is a change-speed gear on the main hoisting operation for fast lifting with lighter loads.

Each of the cranes is erected on a tower approximately 110ft high from foundation level, and the crane towers are connected by a latticed girder bridge at a height of about 45ft. The span of this bridge is 135ft, and two light-gauge railway tracks are placed on the decking, which runs through the 16ft square crane towers. This railway track runs down from the lower mixing plant and traverses a short side span bridge to reach the connecting bridge between the two monotower cranes. The wagons carrying the concrete and other materials thus reach a point where their loads can be comfortably handled by the cranes and deposited directly into position.

These cranes are easily operated by one driver who is situated in the driver's cabin at the top of the towers, where he has a clear and uninterrupted view of the surrounding areas. The general lay-out of the cranes can be seen in the accompanying illustration.

Derrick cranes for general use were also provided, and a 7-ton, two-motor electric derrick crane with 120ft jib was used for the erection of other plant and for general purposes on the contract. This crane can lift 7 tons at 90ft radius or 3 tons at 116ft radius. A 5-ton hand derrick crane with 60ft lattice jib provided with an extension piece 15ft long was also used for general erection purposes. For the receiving stock-yard a 3-ton hand or electric derrick crane with 60ft latticed jib was supplied. When power-driven, it is fitted with a 12 b.h.p. motor, which operates the load at a speed of 40ft per minute, the slewing being carried out by hand worm gear from the driver's platform.

The mono-tower cranes and connecting bridge were designed, supplied and erected by Butters Bros. and Co., Ltd., Glasgow, who also supplied the derrick cranes. The narrow-gauge diesel locomotives were supplied by Ruston and Hornsby, Ltd., Lincoln, and the track by Robert Hudson, Ltd., Leeds.

The Secretary of State for Scotland has appointed Mr. R. W. L. McCaig and Provost George Hendry to fill vacancies on the Electricity Consultative Council for the North of Scotland District. Mr. Mitchell Craig has been appointed Deputy Chairman of the Council.

Behaviour of Cast Steel at Elevated Temperatures*

By A. E. JOHNSON, M.Sc., A.M.I. Mech. E.†

No. III—(*Continued from page 141, August 5th*)

(9) *Consideration of the Isotropic Behaviour of the 0·17 per cent C Steel at 350 deg. Cent.:* (9.1) *Stress-Creep Rate Relations Considered in Relation to Various Theories at 350 deg. Cent.* —In the Appendix a description is given of the theoretical considerations upon which current theories of creep of isotropic metals under complex stress systems are based. It is there shown that in accordance with the generally assumed laws of plastic flow concerning colinearity of principal stress and strain axes, constancy of volume, and the various assumptions regarding relations between stresses and strain, the most likely type of equations to describe creep stress strain relations under complex stress systems are :—

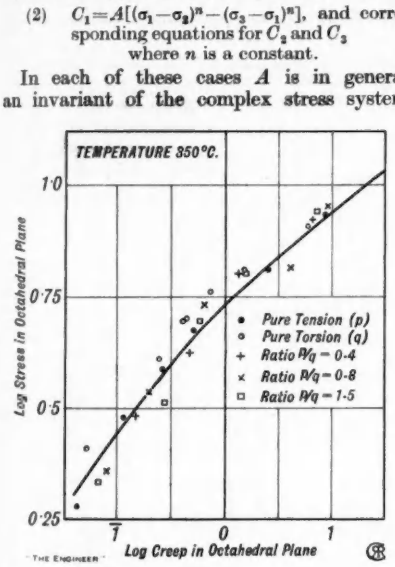
(1) $\dot{C}_1=A[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)]$, and corresponding equations for $\dot{C}_2$ and $\dot{C}_3$.

This equation can be generalised in the form :—

$\dot{C}_1=A\{1+A'[\Sigma(\sigma_1-\sigma_2)^2]\}[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)]$ &c.

(2) $\dot{C}_1=A[(\sigma_1-\sigma_2)^n-(\sigma_3-\sigma_1)^n]$, and corresponding equations for $\dot{C}_2$ and $\dot{C}_3$ where n is a constant.

In each of these cases A is in general an invariant of the complex stress system



The curve shown corresponds with principal plane equations of type

Creep rate $=\{A[\Sigma(\sigma_1-\sigma_2)^2]+A'[\Sigma(\sigma_1-\sigma_2)^2]^{2\cdot5}\}\{(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)\}$ where σ_1, σ_2, σ_3, are principal stresses $A=0\cdot85\times10^{-10}$, $A'=1\cdot0\times10^{-14}$

FIG. 13—*Log. Octahedral Shear Stress—Log. Octahedral Creep Rate Curves for All Stress Systems at 150 Hours*

such as a power or exponential function of the shear strain energy, e.g. :—

$$[\Sigma(\sigma_1-\sigma_2)^2]^m \text{ or } e^{[\Sigma(\sigma_1-\sigma_2)^2]^m}$$

where m is a constant. Under particular circumstances A may deteriorate into a purely arithmetical constant.

A third possible type of equation of the general type :—

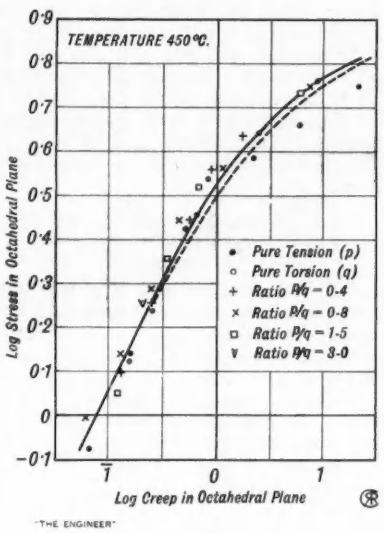
(3) $\dot{C}_1=A\left[e^{C(\sigma_1-\sigma_2)^m}-e^{C(\sigma_3-\sigma_1)^m}\right]$

is discarded on account of certain irregularities associated with the case of pure tension for this material.

A further type of equation has been suggested by Kanter, which is a variant of type (1) in which the function A is replaced by an exponential function of the stress system, which is not an invariant, the equations suggested being of the type :—

$$\dot{C}_1=K[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)]e^{C[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)]}$$

&c., where K and C are constants. It is necessary to discard this type of equation,



The curves shown correspond to the principal plane equations

——— Creep rate $=\{A+A'[\Sigma(\sigma_1-\sigma_2)^2]^2\}\{(\sigma_1-\sigma_2)^{1\cdot9}-1\cdot5(\sigma_3-\sigma_1)^{1\cdot9}\}$, &c. where $A=0\cdot6\times10^{-8}$, $A'=2\times10^{-13}$

— — — Creep rate $=\{A[\Sigma(\sigma_1-\sigma_2)^2]^{0\cdot45}+A'[\Sigma(\sigma_1-\sigma_2)^2]^{2\cdot45}\}\{(\sigma_1-\sigma_2)-1\cdot7(\sigma_3-\sigma_1)\}$, &c., where $A=0\cdot39\times10^{-8}$, $A'=1\cdot8\times10^{-13}$

FIG. 14—*Log. Octahedral Shear Stress—Log. Octahedral Creep Rate Curves for All Stress Systems at 150 Hours*

since it is obvious that the second condition of plasticity, viz., constancy of volume, is not complied with.

We are thus left to consider the general types of equations (1) and (2), and to find some means of judging which type, and, further, what particular variety of that type fits the experimental results.

The most satisfactory means of comparison[17]‡ appears to be upon the basis of the shear stress and strain in the octahedral planes. The stress strain system in these planes, which coincide with the faces of a regular octahedron having axes coinciding with the principal axes of stress and strain, is such that the strain is pure shear strain, normal strain being absent, and the normal stress being simply $\Sigma\sigma_1/3$, i.e., the hydrostatic component of the stress system which does not cause distortion. The normal strain is actually $\Sigma\epsilon_1/3$, which vanishes under conditions of plastic or creep strain.

Moreover, in magnitude the shear strain in these planes is proportional to the resultant of the maximum shear strains, or the distortional strains, and therefore can be looked upon as the " resultant " creep of the stress system, and the shear stress produced proportional to the resultant of the maximum shear stress, i.e., to the distortional strain energy of the stress system or " resultant " distortional stress. A consideration of the octahedral stress and strain therefore would appear to offer a comparison of the stress strain characteristics of the system in the most general form.

Accordingly, for the results at 350 deg. Cent., plots were made of various functions of octahedral shear stress against either the octahedral shear creep rate or of the ratio of octahedral shear rate to octahedral shear stress. These various plots illustrated the applicability or otherwise of various types of creep rate/stress relations. In view of the considerable number of these plots it was thought necessary only to illustrate a few of those which corresponded to relations well representing the experimental behaviour of the material. These plots are shown in Figs. 13 and 15.

Fig. 13 shows a plot of log. octahedral stress σ_0 against log. octahedral creep rate $\dot{C}_0$. It is seen that the experimental points corresponding to the various stress systems are reasonably well disposed around one general curve, thus indicating that the Hencky theory, which postulates that the octahedral strain is a function of the octahedral stress of the system is a reasonably good approximation at this temperature. The curve of Fig. 13 is closely linear in its lower range of stress and therefore suggests that for this material and temperature the dependence of creep rate on stress is of the nature of a power function for lower stresses.

The general type of principal plane equation which corresponds with a power function relation of creep rate to stress is :—

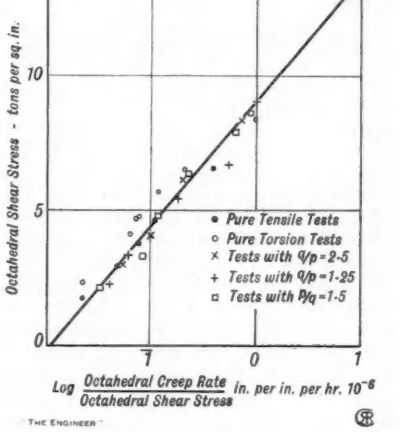


FIG. 15—*Relation Between Log. Octahedral Shear Stress and Log. Ratio* $\frac{\text{Octahedral Creep Rate at 150 Hours}}{\text{Octahedral Shear Stress}}$

$$\dot{C}_1=A[\Sigma(\sigma_1-\sigma_2)^2]^m[(\sigma_1-\sigma_2)^n-(\sigma_3-\sigma_1)^n]$$

where n may=1 or m=0. Corresponding to this equation of course :—

$$\sigma_0=\frac{1}{3}\sqrt{\Sigma(\sigma_1-\sigma_2)^2},$$

and

$$\dot{C}_0=\frac{2}{3}[\Sigma(\dot{C}_1-\dot{C}_2)^2]^{\frac{1}{2}}=\frac{2}{3}A[\Sigma(\sigma_1-\sigma_2)^2]^m$$

$$\{\Sigma[2(\sigma_1-\sigma_2)^n-(\sigma_3-\sigma_1)^n-(\sigma_2-\sigma_3)^n]^2\}^{\frac{1}{2}}.$$

The slope of the lower portion of the curve in Fig. 13 is 3. This may therefore correspond to a principal plane equation of

$$\dot{C}_1=A[(\sigma_1-\sigma_3)^3-(\sigma_3-\sigma_1)^3],$$

&c., or

$$\dot{C}_1=A[\Sigma(\sigma_1-\sigma_2)^2][(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)],\ \&c.$$

Actually the lower portion of the curve in

* Report J/T 137, The British Electrical and Allied Industries Research Association. The full title is " The Behaviour of a Nominally Isotropic 0·17 per cent C Cast Steel Under Combined Stress Systems at Elevated Temperatures."

† National Physical Laboratory.

‡ Bibliography will appear at end of concluding article.—Ed. THE E.

Fig. 13 is the plot of log. σ_0 against log. C_0 where

$$C_0=\frac{2}{3}A[(\sigma_1-\sigma_2)^2]\{\Sigma[2(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)-(\sigma_2-\sigma_3)]^2\}^{\frac{1}{2}},$$

which, of course, corresponds to the principal plane equations just mentioned, A having the value $0\cdot85\times10^{-10}$. This value of A gives the best fit of experimental results in general, a value of $0\cdot94\times10^{-10}$ gives the best fit of tensile results.

It will be noted that the complete curve in Fig. 13 has a final slope of approximate value 6.

It is evident, therefore, that the equation of this complete curve, and the principal plane equation corresponding to it, contain a term dependent on stress to a power 6, which is dominant at higher stresses.

The whole curve in Fig. 13 is a plot of log. σ_0 against log. C_0 where

$$C_0=\frac{2}{3}\{A\Sigma(\sigma_1-\sigma_2)^2+A'[\Sigma(\sigma_1-\sigma_2)^2]^{2\cdot5}\}\{\Sigma[2(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)-(\sigma_2-\sigma_3)]^2\}^{\frac{1}{2}},$$

which corresponds to the principal plane equations

$$C_1=\{A\Sigma(\sigma_1-\sigma_2)^2+A'[\Sigma(\sigma_1-\sigma_2)^2]^{2\cdot5}\}[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)],$$

or

$$C_1=\{A+A'[\Sigma(\sigma_1-\sigma_2)^2]^{1\cdot5}\}[(\sigma_1-\sigma_2)^3-(\sigma_3-\sigma_1)^3]$$

Here the value of A' is so chosen as to make the second term in the brackets tend towards zero as stresses become small. The values of A and A' concerned are respectively $A=0\cdot85\times10^{-10}$ and $A'=1\times10^{-14}$.

In Fig. 10 the stress ratio

$$-\sigma_2/(\sigma_1-\sigma_2)$$

is plotted against the rate ratio $-C_2/C_1$, and lines are shown corresponding to equations of type

$$C_1=A[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)],$$

&c., or

$$C_1=A[(\sigma_1-\sigma_2)^3-(\sigma_3-\sigma_1)^3],$$

and also for the equation

$$C_1=[A(\sigma_1-\sigma_2)-C(\sigma_3-\sigma_1)],\ \&c.,\ \text{for } A=B,\ \text{and } C=1\cdot1A.$$

This equation represents a very slight degree of anisotropy. It appears that the anisotropy indicated by the experimental points is less than that indicated by the above equation.

In Table I a comparison is made of the experimental values of the principal creep rates with those computed for the lower range of stresses on the basis of the equations

$$C_1=[A\Sigma(\sigma_1-\sigma_2)^2]\,[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)],\ \&c.,$$

where A is $0\cdot94\times10^{-10}$ and $0\cdot85\times10^{-10}$ respectively, and also for the whole stress range on the basis of the equation

$$C_1=\{A[\Sigma(\sigma_1-\sigma_2)^2]+A'[\Sigma(\sigma_1-\sigma_2)^2]^{2\cdot5}\},\ [(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)]$$

where $A=0\cdot85\times10^{-10}$, $A'=1\times10^{-14}$.

In Fig. 15 a further plot is shown of octahedral shear stress against the log. ratio

$$\frac{\text{octahedral creep rate}}{\text{octahedral shear stress}}.$$

The experimental points are reasonably disposed about the curve drawn. This line can be shown to correspond to principal plane equations of the type

$$C_1=Ae^{K[\Sigma(\sigma_1-\sigma_2)^2]^{\frac{1}{2}}}[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)].$$

It would appear that such an equation might give an approximation to the experimental results over the whole stress range. On the other hand, the exponential term renders this equation somewhat inaccurate to handle for purposes of computation, and there is little doubt that the equation previously put forward is to be preferred.

(9.2) *The Nature of Anisotropy at the Highest Stresses at 350 deg. Cent.*—The equations discussed in the previous paragraph have application at low and up to moderately high stresses; but, as noted in a previous paragraph, the tests at the highest combined stresses show anisotropy apparently connected with the relatively high initial plastic strains in these tests.

Partly as a result of the currently described tests, and partly as a result of further experimental work on other materials, it is possible to form a fairly definite opinion regarding the nature of this type of anisotropy.

It has been noted that in high combined stress tests considerable initial plastic strain occurs; the effect is apparently to give rise to such anisotropy that in the subsequent creep tests values of C_1 and C_2 tend to arithmetical equality and C_3 towards zero. In other words, the tests tend to simulate pure torsion tests in which the axes of strain are the original principal axes of the combined stress tests. The physical reason for this is not apparent at the moment. It is also noted that isotropy is in all cases preserved in pure tension and torsion tests. In all cases the creep is well represented by equations of the form

$$C_1=F[\Sigma(\sigma_1-\sigma_2)^2]\,[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)]$$
$$C_2=F[\Sigma(\sigma_1-\sigma_2)^2]\,[B(\sigma_2-\sigma_3)-(\sigma_1-\sigma_2)]$$
$$C_3=F[\Sigma(\sigma_1-\sigma_2)^2]\,[(\sigma_3-\sigma_1)-B(\sigma_2-\sigma_3)],$$

where F is a function and B a constant. B here varies with the stress system, but is the same for differing stresses under the same stress system. For all combined stress systems B exceeds unity and increases with increasing p/q. For pure torsion it is unity, since the pure torsion test is apparently the limiting case of the system, and isotropy is therefore preserved in this case. In pure tension B automatically disappears from the above equations, and the behaviour is again isotropic. Thus the state of this type of anisotropy is not independent of the actual stress system.

Values of B for the present steel at 350 deg. Cent. appear to be, for values of $p/q=0\cdot4$, $0\cdot8$ and $1\cdot25$, respectively $2\cdot35$, $3\cdot1$ and $5\cdot75$. Since C_1 is independent of B, in this system of isotropy all relations involving σ_1 and C_1 only remains as in a state of isotropy.

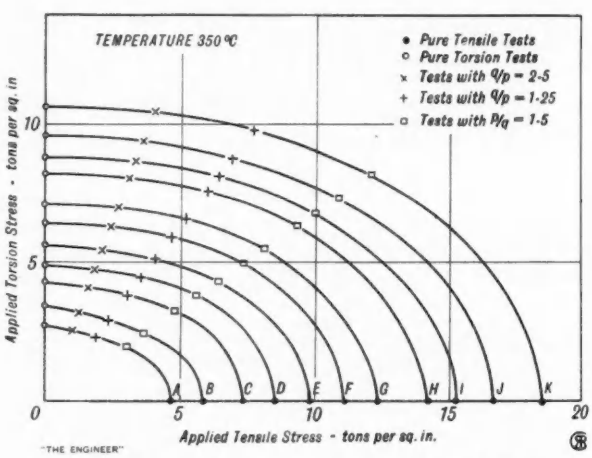
(9.3) *Relation Between Creep Strain and Period of Test at 350 deg. Cent.*—Owing to the fact that any complete analysis of the relations between creep strain and time must involve a knowledge of the behaviour of the material in the third positions of the creep curves, and that any relations based on a consideration of primary and secondary creep only must necessarily be of a very approximate nature, it was decided to leave this matter to be dealt with in a further paper.

The above considerations apply also at 450 deg. and 550 deg. Cent.

(9.4) *Relations Between Applied Stresses to Give Specific Octahedral Creep Rates.*—It is shown in the Appendix that in the case of an isotropic material obeying the Hencky criterion of plastic strain, for any complex stress system consisting of a simple tensile (p), and a simple torsion stress (q), the relation between these two stresses to produce any specific octahedral creep rate is always such that $p^2/P^2+q^2/Q^2=1$, where P is the pure tensile and Q the pure torsion stress, which acting alone would produce the specific octahedral creep rate. Also it is shown that $P=\sqrt{3}Q$; thus the expression may be written $p^2+3q^2=P^2$, or $p^2/3+q^2=Q^2$. These relations are elliptical. Thus it may be seen that provided the material follows the Hencky criterion, the applied tension and torsion stresses corresponding to a particular stress system, required to produce a specific octahedral creep rate, may be written down from a knowledge of either the pure torsion or the pure tensile creep characteristics of the material.

This is true throughout the whole stress and creep rate range, and is quite independent of the nature of the stress creep rate relations. It is to be emphasised, however, that this relation applies only to octahedral creep rates, and is not true of principal creep rates, except as an accidental approximation for particular values of n.

It may be noted that if an assumption is made of either of the relations given in the Appendix for the ratio C_a/C_c it is possible to express the octahedral creep rates in terms of axial or circumferential creep rates, and thus to estimate values of C_a and C_c corresponding to particular values of p and q from pure tensile or torsion creep results. This is, however, purely an approximation, as the form of principal stress strain relations upon which the formulæ for the ratio C_a/C_c rest cannot be determined precisely without combined stress tests. However, from a practical point of view, it appears that use of the above-mentioned assumption would lead to good approximations for the values of C_a and C_c.



A	Creep rate	$0\cdot05\times10^{-6}$	*G*	Creep rate	$1\cdot0\times10^{-6}$
B	Creep rate	$0\cdot10\times10^{-6}$	*H*	Creep rate	$2\cdot0\times10^{-6}$
C	Creep rate	$0\cdot20\times10^{-6}$	*I*	Creep rate	$3\cdot0\times10^{-6}$
D	Creep rate	$0\cdot30\times10^{-6}$	*J*	Creep rate	$5\cdot0\times10^{-6}$
E	Creep rate	$0\cdot50\times10^{-6}$	*K*	Creep rate	$10\cdot0\times10^{-6}$
F	Creep rate	$0\cdot70\times10^{-6}$			

FIG. 16—*Values of Applied Tensile and Torsion Stresses to Give Specific Octahedral Shear Creep Rates at 150 Hours (Inch per Inch per Hour)*

For the temperature 350 deg. Cent., Fig. 16 gives a plot of the relations between p and q for several specific octahedral creep rates. It will be seen that the points lie on smooth quadrants of ellipses. Other quadrants of the ellipse would be involved for tension and torsion strain of reversed sign.

(9.5) *Values of Major Principal Creep Rate for Specific Values of Principal Stresses at 350 deg. Cent.*—In Fig. 17, for a range of

values of the major principal stress σ_1, combined with minor principal stress σ_2, having values of σ_2 ranging from $\sigma_2=\sigma_1$ through $\sigma_2=0$ to $\sigma_2=-\sigma_1$, the log. major principal creep rate is plotted, being computed from the experimentally derived equations

$$C_1=\{A\Sigma(\sigma_1-\sigma_2)^2+A'[\Sigma(\sigma_1-\sigma_2)]^{2\cdot5}\}\ (2\sigma_1-\sigma_3),$$

where $A=0\cdot85\times10^{-10}$, $A'=1\cdot0\times10^{-14}$ and $\sigma_3=0$.

The values given in this figure should holds for an isotropic material, it may be shown that the applied tensile stress p and the applied torsion stress q, under any given complex stress system, consisting of a simple tensile and a simple torsion stress, required to produce a specific octahedral creep rate, are related by the equation $p^2/P^2+q^2/Q^2=1$, where P and Q are the pure tensile and pure torsion stresses respectively required to produce the specific creep rate when applied singly. This relation was found to hold with

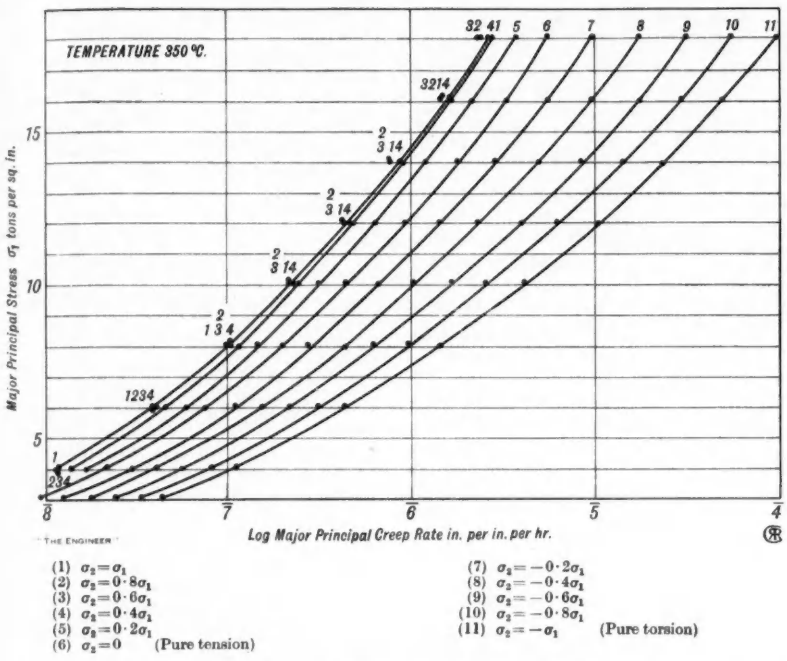


FIG. 17—*Major Principal Stress—Major Principal Creep Rate for Various Values of the Minor Principal Stress and Based on the Equation* $C_1=[A\Sigma(\sigma_1-\sigma_2)^2+A'\{\Sigma(\sigma_1-\sigma_2)^2\}^{2\cdot5}]\ (2\sigma_1-\sigma_3)$, *where* $A=0\cdot85\times10^{-10}$, $A'=1\cdot0\times10^{-14}$ *and* $\sigma_3=0$

enable the great majority of complex stress creep problems in which material of this type is concerned to be reasonably approached.

A feature of the diagram is the small change in value of the major principal creep rates with decreasing value of the minor principal stress σ_2 from $\sigma_2=\sigma_1$ to $\sigma_2=0\cdot4\sigma_1$.

(9.6) *Conclusions Relating to the Steel at 350 deg. Cent.*—(1) The behaviour of the steel is essentially isotropic at this temperature at all except the highest stresses. At these later stresses anisotropy occurs apparently due to high initial plastic strain.

(2) The octahedral shear strain appeared for all stress systems to be closely a function of the octahedral shear stress, i.e., the Hencky criterion of plastic flow appeared to be fulfilled approximately for the material.

(3) The principal creep rate, stress, relations at a specific period over the whole range of stress and time investigated (with the exception of the highest stresses) may reasonably be represented by equations of the form

$$C_1=\{A[\Sigma(\sigma_1-\sigma_2)^2]+A'[\Sigma(\sigma_1-\sigma_2)^2]^m\}\{(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)\},$$

&c., where A, A', B, m and p are constant.

These equations conform equally with the simple and generalised St. Venant and also the Bailey theories.

At the highest stresses the equations assume the form

$$C_1=F[\Sigma(\sigma_1-\sigma_2)^2]\,[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)]$$
$$C_2=F[\Sigma(\sigma_1-\sigma_2)^2]\,[B(\sigma_2-\sigma_3)-(\sigma_1-\sigma_2)]$$
$$C_3=F[\Sigma(\sigma_1-\sigma_2)^2]\,[(\sigma_3-\sigma_1)-B(\sigma_2-\sigma_3)],$$

where F is a function and B a constant.

(4) If the Hencky theory of plastic strain reasonably good approximation for the present material at 350 deg. Cent.

(10) *Consideration of the Effects of Anisotropy on the Behaviour of the 0·17 per cent C Steel at 450 deg. and 550 deg. Cent.*—The nature of the anisotropy at 450 deg. and 550 deg. Cent. has already been indicated. In the following paragraphs the effects of this anisotropy on stress and strain and other relations are considered.

(10.1) *Stress Creep Rate Relations Considered in Relation to Various Theories:* (10.1.1) *at 450 deg. Cent.*—At this temperature a plot of

$$\sigma_2/(\sigma_1-\sigma_2),$$

against C_3/C_1 appeared to indicate that the anisotropy present at all except the highest stresses was of a reasonably simple nature. Analysis of further results confirmed this view. The anisotropy occurring at the highest stresses was generally similar to that at the highest stresses at 350 deg. Cent.

In conformity with the examination of similar circumstances made at 350 deg. Cent., the linearity of the curve in Fig. 14 at lower stresses, were the material at 450 deg. Cent. completely isotropic, would indicate that the principal plane equations were of the general type

$$C_1=A[\Sigma(\sigma_1-\sigma_2)^2]^m[(\sigma_1-\sigma_2)^n-(\sigma_3-\sigma_1)^n],$$

where m may=0 and n may=1. The power index $2m+n$ here corresponds to the slope of the curve in Fig. 14 at lower stresses, which by measurement gives the value 1·9.

Now a simple type of anisotropy may be expressed in terms of equations of the above general type by rewriting them.

$$C_1=[\Sigma(\sigma_1-\sigma_2)^2]^m[A(\sigma_1-\sigma_2)^n-C(\sigma_3-\sigma_1)^n],\ \&c.$$

Since $(2m+n)=1\cdot9$, it is evident that the only choice at this temperature is probably between equations of type

$$C_1=[\Sigma(\sigma_1-\sigma_2)^2]^{0\cdot45}[A(\sigma_1-\sigma_2)-C(\sigma_3-\sigma_1)],$$

and

$$C_1=[A(\sigma_1-\sigma_2)^{1\cdot9}-C(\sigma_3-\sigma_1)^{1\cdot9}]$$

The former is recognisable as an anisotropic form of the equations of Marin and Soderberg, while the latter is a special case of the form put forward by Bailey[18]‡ for the case of anisotropy. It may be objected that if the first term in the initial equation be regarded as signifying the effect of the shear strain energy of the system on the creep, that from a physical point of view it is difficult to conceive of the shear strain energy term being present to some fractional power. This was the view put forward by Bailey in justification of the second type of equation.

It would seem that if the first term be regarded as a function of shear strain energy for an isotropic material, the form $\Sigma(\sigma_1-\sigma_2)^2$ requires some modification. It is suggested that the form $\Sigma A(\sigma_1-\sigma_2)^2$ is more appropriate in the case of the first equation

$$C_1=[\Sigma A(\sigma_1-\sigma_2)^2]^{0\cdot45}[(\sigma_1-\sigma_2)-C(\sigma_3-\sigma_1)],\ \&c.$$

Considering the plot of

$$-\sigma_2/(\sigma_1-\sigma_2)$$

against $-C_3/C_1$, shown in Fig. 11, it will be seen that while the experimental points diverge (for values of $p/q>1\cdot5$) from the plot corresponding to the isotropic equation

$$C_1=A[(\sigma_1-\sigma_2)^{1\cdot9}-(\sigma_3-\sigma_1)^{1\cdot9}]$$

they are quite reasonably well disposed with respect to the lines corresponding to the anisotropic equations

$$C_1=[\Sigma(\sigma_1-\sigma_2)]^{0\cdot45}[A(\sigma_3-\sigma_1)-C(\sigma_3-\sigma_1)],$$

where $B=C=1\cdot7A$,

$$C_1=[A(\sigma_1-\sigma_3)^{1\cdot9}-C(\sigma_3-\sigma_1)^{1\cdot9}],\ \text{where } B=C=1\cdot5A,$$

and

$$C_1=[A(\sigma_1-\sigma_2)^{1\cdot9}-C(\sigma_3-\sigma_1)^{1\cdot9}],\ \text{where } B=2A,\ C=1\cdot8A.$$

The first two equations give the better mean representation, while the latter represents more closely the behaviour at high values of p/q. The lower portions of the curve in Fig. 14 correspond to the second equation.

Considering now the remainder of the curve in Fig. 14, the final slope of the curve is of approximate value 6, and it is evident that the equation must contain a stress term of power 6, which is dominant at higher stresses and negligible at lower stresses.

The two curves shown in Fig. 14 are respectively plots of log. σ_0 against log. C_0, where

$$C_0=2/3\{A+A'[\Sigma(\sigma_1-\sigma_2)^2]^2\}\{\Sigma[2(\sigma_1-\sigma_2)^{1\cdot9}-1\cdot5(\sigma_3-\sigma_1)^{1\cdot9}-1\cdot5(\sigma_2-\sigma_3)^{1\cdot9}]^2\}^{\frac{1}{2}}$$

and

$$C_0=2/3\{A[\Sigma(\sigma_1-\sigma_2)^2]^{0\cdot45}+A'[\Sigma(\sigma_1-\sigma_2)^2]^{2\cdot45}\}\{\Sigma[2(\sigma_1-\sigma_2)-1\cdot7(\sigma_3-\sigma_1)-1\cdot7(\sigma_2-\sigma_3)]^2\}^{\frac{1}{2}}.$$

In the first expression $A=0\cdot6\times10^{-8}$ and $A'=2\times10^{-13}$, in the second $A=0\cdot39\times10^{-8}$ and $A'=1\cdot8\times10^{-13}$.

The former curve fits the general run of points more closely, while the latter is closer to the tensile test results.[19]‡

It is evident that these two lines do not differ a great deal and that quite a good fit of experimental points is given by them. The expressions for C_0 represent the experimental results quite well over the stress range investigated, but for higher stresses approaching the value of the short-time fracture stress it is possible that further power functions of shear strain energy should be added to the initial term. It is likely that a somewhat better fit would be obtained by use of the anisotropic strain energy expression sug-

gested in a previous paragraph in place of $\Sigma(\sigma_1-\sigma_2)^2$.

In Table II (page 140, August 5th) the experimental creep rates are compared for the whole stress range with values computed on the basis of the three equations

$$C_1=\{A+A'\Sigma(\sigma_1-\sigma_2)^2\}[(\sigma_1-\sigma_2)^{1\cdot9}-1\cdot5(\sigma_3-\sigma_1)^{1\cdot9}],\ \&c.,$$

where $A=0\cdot6\times10^{-8}$ and $A'=2\times10^{-13}$;

$$C_1=\{A[\Sigma(\sigma_1-\sigma_2)^2]^{0\cdot45}+A'[\Sigma(\sigma_1-\sigma_2)^2]^{2\cdot45}\}[(\sigma_1-\sigma_2)-1\cdot7(\sigma_3-\sigma_1)],\ \&c.,$$

where $A=0\cdot39\times10^{-8}$ and $A'=1\cdot8\times10^{-13}$;

$$C_1=\{A[(\sigma_1-\sigma_2)^2+1\cdot7(\sigma_2-\sigma_3)^2+1\cdot7(\sigma_3-\sigma_1)^2]^{0\cdot45}+A'[(\sigma_1-\sigma_2)^2-1\cdot7(\sigma_2-\sigma_3)^2+1\cdot7(\sigma_3-\sigma_1)^2]^{2\cdot45}\}[(\sigma_1-\sigma_2)-1\cdot7(\sigma_3-\sigma_1)],$$

&c., where $A=0\cdot34\times10^{-8}$ and $A'=0\cdot8\times10^{-13}$ and for the lower range of stresses on the bases of equations

$$C_1=A[(\sigma_1-\sigma_2)^{1\cdot9}-1\cdot5(\sigma_3-\sigma_1)^{1\cdot9}],$$

&c., where $A=0\cdot6\times10^{-8}$;

$$C_1=A[\Sigma(\sigma_1-\sigma_2)^2]^{0\cdot45}[(\sigma_1-\sigma_2)-1\cdot7(\sigma_3-\sigma_1)],$$

&c., where $A=0\cdot39\times10^{-8}$;

$$C_1=A[(\sigma_1-\sigma_2)^2+1\cdot7(\sigma_2-\sigma_3)^2+1\cdot7(\sigma_3-\sigma_1)^2]^{0\cdot45}[(\sigma_1-\sigma_2)-1\cdot7(\sigma_3-\sigma_1)],$$

where $A=0\cdot34\times10^{-8}$. It will be observed that arithmetically there is not a great deal of difference between the order of agreement between any of these equations and the experimental results. If anything, the equation with the anisotropic form of the initial term is the best, particularly in its representation of the higher tensile rates of creep. It is obvious, however, that from a practical point of view little difference exists.

(To be continued)

Nomenclature

Applied tensile stress	p
Applied torsion stress	q
Major principal stress	σ_1
Minor principal stress	σ_3
Secondary principal stress	$\sigma_2=0$ in all tests
Axial creep rate	C_a
Circumferential creep rate	C_c
Creep rate in direction of major principal stress	C_1
Creep rate in direction of minor principal stress	C_2
Creep rate in direction of secondary principal stress	C_3
Time	t
Angle between direction of major principal stress and axis of specimen	ϕ
Ratio q/p	a
Quantity $\sqrt{1+4a^2}$	b
Octahedral shear stress	σ_0
Octahedral shear creep rate	C_0
Principal strains	ε_1, ε_2, ε_3

American Railroads

No. I

(Contributed)

DIESEL-ELECTRIC AND OTHER TRACTION EQUIPMENT IN THE UNITED STATES AND CANADA

IF, in getting a notion of the service provided by the New York Subways, the visitor spends ten cents on a journey to Coney Island—and better value is not obtainable to-day from any transport organisation—he will find the model railway at that unique place to be equipped with oil engine operated, streamlined trains. These trains are just replicas in miniature of those diesel-electric trains which are the outstanding feature of up-to-date rail transport in the United States.

A new industry has grown up in connection with this revolution in railway equipment and at the present time the construction of diesel-electric locomotives (and of the streamlined trains which they will haul) is one of the healthiest industrial activities in the United States. To a British visitor contemplating this great development, there will come a recollection of the pioneer effort made on the Canadian National Railways as long ago as 1929, when diesel-electric road locomotives were first introduced. The power units—as many of them are now—were of the four-cycle "V" type, with twelve cylinders, the builders being William Beardmore and Co., Ltd., Glasgow, and the designer the late Mr. Alan E. L. Chorlton. This courageous enterprise represented a collaboration between the Canadian National Railways, Beardmore's, Westinghouse and the Canadian Locomotive Company, but it was not followed up until long afterwards and the locomotives appear to have ended their lives during the second world war as armoured units on the West Coast. Some of the Beardmore-Westinghouse diesel-electric railcars are, nowever, still in regular service on the Canadian National Railways and their power units must be among the very earliest direct-injection engines ever installed for rail traction purposes.

In studying the impulse behind the great revolution in American railroad traction now in process, it strikes an observer that one factor contributing to the "dieselisation"—as it is called—lies in the stormy labour climate on the coalfields. This imperils, among other things, the availability of locomotive coal and the recurring coal stoppages, through their paralysing effect on steam-operated railways, have certainly contributed to the progressive abandonment of the steam locomotive. This is brought home to the passenger who chances to watch the refuelling of diesel locomotives. The present writer took note of the rapidity and ease with which the diesel locomotives hauling the "Empire State Express" were refuelled and replenished with cooling water at Buffalo. The hoses were connected and the entire operation completed with astonishing celerity, the locomotives being then ready to continue the journey to Cleveland.

The fuelling of steam locomotives which—like the "Mohawks" of the N.Y.C. and H.R.R.—haul fourteen-wheeled tenders containing, say, 46 tons of coal, is no small matter even where the availability of the coal can be depended upon. The watering from track tanks is easy, but the water requirements of a "Mohawk" or a "Hudson" call for an appreciable addition to the weight of the tender, the water capacity of which is 18,000 gallons. With labour conditions as they are and so long as the fuel oil supplies remain adequate, the future prospects of the coal-burning steam locomotive in the United States appear to be no better than those of the horse omnibus and the wax candle. Indeed, the scrapping of steam locomotives goes merrily on and we read that the Conway Yard of the Pennsylvania R.R. is able to scrap three engines a day. Another scrap yard in Pennsylvania dealt, in 1948, with 250 locomotives and an American railway paper reports that "up to 95 per cent of each scrapped locomotive is recovered for the steel mills of the Pittsburgh area. . . . At present the junk yards are paying about 33 dollars a ton for old locomotives."

The number of diesel-electric locomotives already delivered by builders in the United States is placed at 7000 with an aggregate capacity approaching 10,000,000 h.p. Though the output of these locomotives is rapidly increasing, there remain on the railroads of the United States some 35,000 steam locomotives, the greater part of them being of comparatively modern type. Indeed, large numbers are of highly advanced design and large power. It is the replacement of this immense fleet of coal-burning steam locomotives which gives such scope to the manufacturers of the diesel-electric type. The great American Locomotive Company of Schenectady, with a century of experience, has not turned out a steam locomotive since April, 1948, and one reads (shades of George Stephenson!) that when an A.L.C.O. 4000 h.p. diesel-electric locomotive was recently "baptised" by the daughter of the President of the Erie R.R., "a bottle of smoke, symbolising the passing of the steam locomotive service from Cleveland switching and passenger operations on the Erie, was used for the christening."

Of the makers of diesel-electric locomotives, the leader is, of course, the Electro-Motive Division of General Motors, who manufacture their locomotive equipments at La Grange, Ill., under mass-production methods, which, for scope and completeness, have never previously been seen in the construction of railway locomotives. The degree of standardisation is such that apart from non-essential decoration, styling and fittings, one Electro-Motive locomotive is identical with all others of the same type and series.

Next in point of manufacturing capacity comes the American Locomotive Company, Schenectady, which has been in the steam locomotive business since 1848. In this case the electrical components of the locomotives are manufactured by The General Electric Company. Following the Electro-Motive Division ("G.M.") and the American Locomotive Company ("A.L.C.O.") come Fairbanks-Morse and Co., and the Baldwin-Westinghouse combination.

It is interesting to note that while the Electro-Motive Division uses the standard General Motors 8in by 10in "V" type two-stroke engine, which, in its most usual cylinder arrangement, gives a rating (power delivered to generator) of 1500 h.p., the American Locomotive Company uses its standard "A.L.C.O." "V" type four-stroke turbo-pressure-charged engine, which, with cylinders 9in by 10½in and in the twelve-cylinder arrangement, also gives a rating (power delivered to generator) of 1500 h.p. Fairbanks-Morse and Co. use their own opposed-piston two-stroke engine, built in cylinder aggregates of 6, 8, 10 and 12, the output per cylinder being round about 200 h.p.

Time alone will show just how the radically different types of engine compare in overall performance, the assessment of which is a complicated matter, having regard to the variety of technical, operational and commercial factors involved. Certain it is that a vast amount of research and development has been accomplished by all concerned, and the railway engineering world will await with lively interest the delivery of the confirmatory facts. It does seem to the observer who travels in the diesel-electric trains and examines their equipment that the present tendency in the United States is to use only one generating set per locomotive unit, the cab being carried on two four-wheeled trucks,

all axles being, of course, driving axles. The necessary aggregate of power is provided by increasing the number of locomotive units in multiples of 1250/1500 h.p. The same locomotives are commonly used for long distance fast freight trains as for the fast and heavy passenger trains.

A notable instance of up-to-date construction is provided by the new General Motors "F7," successor to the well-known "F3" series which first appeared in service at the end of 1946. The "F7" is mounted on two 4-wheeled trucks, and owing to improvements in traction motor design is said to haul, at continuous rating, 25 per cent more weight on a 1 per cent grade than does the "F3," and to haul up to 33 per cent more weight on two hours rating. Not without significance is the fact that in their new locomotives, General Motors have much increased both the train-heating capacity and the water carrying capacity. For example, in the new "E8" successor to the "E7," General Motors have space in each unit for two 2500 lb steam generators, so that a 4500 h.p. two-unit diesel-electric locomotive can provide 10,000 lb of steam in four generators. In the old "F3-As" the single steam generator had a capacity of only 1600 lb. Much attention is certainly being devoted both in the United States and Canada to this important question of the heating of "dieselised" trains. Combustion Engineering-Superheater, Inc., is reported to be building special train heating boilers which will be known under the established name of "Elesco."

Regarding operational hazard, a great deal of study has been given to the avoidance of complete road failures caused by the immobilising of the diesel-electric locomotive from whatever cause arising. This has already brought about the almost invariable use (on road service) of multiple units, though even with multiple units certain hazards remain. For example, the Interstate Commerce Commission has lately reported on three derailments of passenger trains hauled by multiple-unit diesel-electric locomotives. In each case the accidents are attributed to over-heated traction motor bearings. One of the reports notes that the present practice is to operate diesel units on an assigned mileage basis between overhauls of traction motor bearings. The report goes on to remark that "it is essential that the bearings be properly and adequately designed and that the utmost care must be exercised in the inspection and operation of these bearings during operating periods if accidents are to be avoided."

As for the diesel engine units themselves, the preponderance of the two-cycle type is very marked. Taking the latest General Motors particulars, it is stated that the "567A" engine is proved capable of 94 h.p. per cylinder with "exceptionally long economical life." On this rating the two twelve-cylinder engines in the latest model (the "E8") give 1125 h.p. each, the total per two-engine unit (one cab) being thus 2250 h.p. The battle between the two-stroke engine, the turbo-pressure charged four-stroke, and the opposed piston two-stroke is now on and time alone will determine their respective merits in traction service on railroads.

To mention now the views expressed by the locomotive crews, on nearly every occasion when the present writer talked with the drivers of diesel-electric locomotives on fast passenger trains, they affirmed most emphatically that, from their point of view as drivers, the advantage of the diesel-electric over the steam locomotive was not to be questioned. Certainly the driver of a large diesel-electric locomotive is very happily situated relatively to operational comfort. He has, for example, a toilet compartment, something not practicable on a normal steam locomotive. He sits in a most comfortable seat in a clean, dust-free cabin entirely glazed in front. He controls the locomotive with less effort than a tram-driver controls a tram-car, and he has for his guidance, immediately before his eyes, instruments which tell him, at a glance, just what power he is using and at what speed he is running. These are among the amenities which led a driver on the "Empire State Express" to declare that diesel-electric locomotives "have the steam locomotive beaten by 100 per cent."

The United States railroads very well recognise the fact that they are faced with a new problem in the servicing of diesel-electric locomotives. This involves the establishment of schools for the tuition of drivers and repair crews and the provision of adequate repair shop facilities contrived with a view to the accurate and expeditious execution of all necessary maintenance work. A recent example is to be found in the diesel repair shop established at Chattanooga, Tenn., by the Southern Railway. Like attention is being given to the provision of oil lines, water lines, vacuum pump discharge lines, vent pipes, &c., at the various replenishing points, the operations at night being carried on under flood-lights in specially equipped sidings. It appears to be accepted practice on the American railroads to discourage pitting by the use of wrought iron pipe in underground oil lines, returns and drip piping, vacuum pump discharge lines, all vent pipe above ground, &c.

Passenger Services

Irrespective of the type of motive power used, the operation of passenger trains in the United States is, under present conditions, a severe burden on properties paid for and operated by private enterprise. Speaking on this very matter, the President of the Gulf Mobile and Ohio R.R. has remarked that "if we were freed from the obligation to run any passenger trains, our financial condition would be much improved." The same experienced railway executive went on to observe that "the mere fact that a railroad loses money on a particular service is not necessarily justification for eliminating it. The real need of the public must be met even at a loss, provided the loss does not jeopardise the permanent stability of the company which sustains it." Another eminent authority—Mr. William T. Faricy, President of the Association of American Railroads—has stated that "there never has been and never will be a ceiling on improvement in railroad operations and services. Railroad management and railroad employees never rest on past accomplishments; they are never satisfied with what has been done, but instead are always looking for ways and means of doing better."

On the subject of the cost of streamlined trains complete with locomotives, it is stated that while the two trains required for the "Liberty Limited" (Washington–Baltimore–Chicago) service of the Pennsylvania R.R. cost, in 1949, 4,276,600 dollars, the cost of the two trains with which the service was inaugurated in 1923 was only 584,800 dollars. The modern (1949) trains are hauled by electric locomotives south of Baltimore and by diesel-electric locomotives onward to Chicago. Billions of dollars are being laid out on new streamlined passenger train equipments, diesel-electric locomotives and other items involved in the creation of luxury transportation by railroad. Moreover, this is all done without help from the taxpayers. In point of fact, the railroads of the United States actually pay into the public treasury taxes amounting in each year to almost 4000 dollars per mile. To-day, the cost of maintenance, replacement and improvement is twice what it was in 1939. It appears to be still rising. One wonders, indeed, what may be the economics of the luxury day coaches on American "feature" trains. They are delightful to travel in, but there must be a ceiling somewhere to the overall cost (including haulage) if passengers continue to be carried for an average charge of 2½ cents a mile, the figure currently advertised by the Association of American Railroads. In this connection, it amazed the present writer to find, on returning from the United States, that the fare which he paid for a first-class seat in the "Ocean Special" from Southampton to Waterloo worked out at between 4d. and 5d. per mile, though the toilet compartment contained neither soap, water nor towels.

We have already described the steam locomotive in the United States as on the way out, but it must not be supposed that this venerable machine has any reason to blush for its speed performances either to-day or in times past. For example, the 4–6–4s of 1938 with 84in driving wheels gave remarkable performances with the "Hiawathas," and there is a record of one of them which made the run from Milwaukee to Chicago (85 miles) in 68 min. 30 sec. It must have been a stirring sight to see this Schenectady-built 415,000 lb streamlined monster flying across the streets of Sturtevant at about 130ft a second. Indeed, when viewing the massive development of diesel-electric road locomotives in the United States it should be made clear that the American railroad speed record has not passed to the newcomer. There is no threat yet to the record made as long ago as June 12, 1905, when the "Broadway Limited" (then called the "Pennsylvania Special"), comprising four cars hauled by an "Atlantic" type locomotive, is said to have attained a speed of 127·1 m.p.h. over a distance of 3 miles.

Turning now to railroad electrification in the United States, this is proceeding cautiously, the accent as regards traction, equipment remaining overwhelmingly on the diesel-electric locomotive. Nevertheless, such equipments as the 1,000,000 lb motor-generator type locomotives built by the General Electric Company for the Virginian Railway indicate the progress made. These mighty machines (of which four were delivered early in 1948) are designed to haul 6000-ton trains over the Allegheny Mountains between Mullens, W. Va., and Roanoke, Va., a route containing the tremendous ascent from Elmore to Clark's Gap, where the grade goes to 2·11 per cent. The continuous rating of the locomotives is 6800 h.p. at rail, the tractive force being 162,000 lb, speed 15·75 m.p.h. The total wheel base is 133ft 10in, the rigid wheel base (four-wheeled trucks) being 9ft. The single-phase, 25-cycles contact-line voltage is 11,000V, and the power is taken from the railway company's own coal-burning power station at Narrows, Va. It is to be noted that the traction motors used on these all-electric locomotives are duplicates of traction motors in extensive use on large diesel-electric locomotives, standard apparatus being employed wherever possible. There is, moreover, a tendency, in American main line electric locomotives, to the use of two four-wheel trucks, an arrangement already well established on the Swiss railways and strongly marked in new American diesel-electric road locomotives.

Outstanding among the main line electrifications on the American railroads is that of

the Pennsylvania, the electrically operated service between New York and Washington being a most impressive example of this type of working. The distance from New York (Penna. Station) to Washington (Union Station) by the Pennsylvania Railroad is 226·6 miles, there are twenty-two trains in each direction daily, and the intermediate points along the route include Newark (N.J.), Philadelphia (Pa.), Wilmington (Del.) and Baltimore (Md.).

The heavy passenger trains are hauled by 4-6-6-4 locomotives having a rating around 5000 h.p., and in the case of "The Congressional" (train No. 152, 3 p.m. ex-Washington), the 226·6 miles are covered in 215 min., with intermediate stops at Baltimore, Wilmington, North Philadelphia, Philadelphia (30th Street) and Newark. The booked average speed inclusive of stops is 63·16 m.p.h. For the stretch from Baltimore to Wilmington (68·4 miles) the time allowed is 59 min., which includes the stoppage time at Wilmington. Excluding any allowance for the time spent at Wilmington, the average speed, Baltimore to Wilmington, is just a fraction under 70 m.p.h. Between North Philadelphia and Newark (a distance of 75·9 miles), the time allowed (arriving at North Philadelphia to arriving at Newark) is 65 min., giving an average speed of almost exactly 70 m.p.h.

The train includes parlour cars, buffet lounge, dining car and day coaches, a special feature being the provision, in the lounge car, of a telephone enclosure enabling passengers to make or receive calls on this extremely fast train. The corresponding south-bound train (No. 153) leaving New York (Penna.), at 3.30 p.m. has similar telephone facilities. Both these trains are allowed the same inclusive time between New York and Washington and they make stops at the same intermediate points.

The steam turbo-electric locomotive does not appear to be proving a serious competitor with the diesel-electric, though some large examples of the type are in service on the Chesapeake and Ohio. As for the gas-turbine locomotive, one 4000 h.p. example (G.E.C.) of the oil-burning gas turbine electric locomotive has been experimented with on the Erie Railroad. The indications are stated to be good and one meets American (and Canadian) railway engineers who regard the high-powered gas turbine locomotive as destined to make strong progress in the traction field. So far as the North American Continent is concerned, the very low air temperatures met with at certain times and in certain regions should certainly be favourable for gas turbines. This, indeed, is a circumstance which has attracted the particular attention of the motive power departments of the Canadian Railways. Nothing definite will be known as to the coal-burning gas turbine locomotive until the first experimental equipment has been exhaustively tested. Actual road tests should commence in 1950.

Regarding passenger rolling stock, the activity and originality of the American railway car builders, such as the Pullman-Standard, Budd and American Car and Foundry, is rapidly changing the aspect of passenger trains. Particularly noteworthy in this connection is the great multiplication of stainless steel car bodies, a development in which the Budd Company has been specially conspicuous. They also pioneered the "vista-dome" construction, now an increasingly popular feature. Outstanding on new car construction is the use of all-coil springing, bolster anchors and roll stabilisers. The 6-wheeled bogie is rarely found in new passenger stock, and the present writer saw no new passenger vehicles whether day coach, parlour car, diner or sleeping car on other than 4-wheeled trucks. By the use of steel castings for parts such as combined platforms and body bolsters, truck frames, &c., welds and rivets are eliminated and the alloy steel used is selected with a view to its high resistance to impact shocks. Conspicuous attention is paid to all procedures likely to afford maximum strength and minimum maintenance. The babbitted journal bearing has disappeared from all new passenger coach construction, the roller bearing (in various forms) being standard. The smooth and comfortable riding of the modern American passenger coach provides powerful evidence as to the skill of the designers and the adequacy of the material and workmanship.

The seating in new day coaches is of unbelievable comfort, and in what is called "The Sleepy Hollow Chair," contrived with the collaboration of a noted Harvard Anthropologist, the day coach chair is playing a real part in attracting passengers. The same imagination is shown in the new dining cars where, apart from truly superb kitchen equipment, automatic dishwashers, dry-ice refrigeration, air-conditioning, &c., the floors are carpeted, the lighting is perfect and the tables are side-suspended for the greater convenience of those seated at them.

As for the use of radio on the new streamlined trains, a conspicuous example is found in the "Southern Belles," running between Kansas City and New Orleans. Each train has 100 speakers, a control centre in the observation lounge car being equipped with a pair of magnetic reproducers for six hours of continuous recorded music, and a radio receiver pre-tuned to seventeen broadcasting stations along the route. The present writer was much diverted, on long journeys, by the excellent programmes and clear transmission.

It must not be supposed that the possibility of lightweight trains is being neglected in the United States, where tests have recently been carried out to explore the operational advantages claimed for the "Talgo" train, a Spanish development in which, utilising aircraft experience, extremely low weights have been reached.* Three such trains are being built by the American Car and Foundry Company, and one of them has already made trial runs over the tracks of the Delaware, Lackawanna and Western. In this train, six two-wheeled articulated coach units (one a baggage car) are hauled by a diesel-electric locomotive built by American Car and Foundry, the power being supplied by two 405 h.p. "Hercules" "V" type engines driving General Electric d.c. generators. The five-coach passenger unit weighs only 37,400 lb, and the baggage unit 6300 lb. The locomotive has a service weight of 135,000 lb. Air-conditioned, flourescent-lighted and equipped with kitchenette and toilet facilities, the "Talgo" train represents a radical departure of much technical interest and the trains built by the American Car and Foundry Company will be used on fast passenger services between Madrid and the Spanish-French frontier. Time will show whether the application of aircraft ideas in railway equipment can be encouraged on the railroads of the United States.

Referring once more to bearings on railroad vehicles, it is to be noted that while roller bearings are invariable on the high-speed trucks of the new streamlined passenger trains, the vast majority of the freight cars are still on journal bearings. With the now obligatory use of cast steel truck sides (into which the bearing housings are cast solid), the introduction of roller bearings on existing stock involves a great deal of study. In view of the astronomical numbers of A.A.R. approved cast steel truck sides (there are some 1,700,000 freight cars in use on the railroads of the United States), any modification to bearing housings which might be necessitated by the change-over to roller bearings calls for very heavy expenditure. This situation brings home the conditions involved where all the freight car trucks on the railroads of the United States and Canada are made to agreed standards. Very impressive, indeed, is the establishment, on the North American Continent, of overall standards in respect of truck sides, power operated hand brakes (shortly to be made obligatory on all American and Canadian freight cars), A.B. brake equipment and draft gear.

The old "arch-bar" fabricated truck sides are no longer permitted to pass from Canadian on to United States lines, and the obligatory use of the cast steel truck sides has certainly lessened the hazard of pile-ups on busy tracks. It has to be remembered that the movement of freight on United States railroads is carried on at comparatively high speeds, all vehicles being piped for air brake operation. With freight trains of such weight and speed there is no need to enlarge on the consequences of a wreck due to the failure of a truck side. During journeys covering some thousands of miles on United States railroads in the East and the Middle West, the only arch-bar fabricated truck sides seen by the present writer were under a very few cabooses. He saw no freight car, box-type or open-sided, with other than cast steel bogie truck frames.

In conclusion, it may be observed that the Canadian Railways take a more conservative view of the claims made for diesel-electric traction, the comparatively low density of passenger train traffic imposing a restraining influence. Again, a very serious consideration in Canada is the heating of heavy passenger trains in winter. This is no small problem even with large steam locomotives in territory where the temperature can fall to 50 deg. below. While going over rapidly to diesel-electric switching locomotives (many of such equipments being now in use and on order for both the Canadian National and the C.P.R.), the Canadian railways are not likely, for their passenger working, to make any move away from the steam road locomotive until the economics of diesel-electric and gas-turbine electric traction have been more thoroughly tested. Meantime, they are not ordering any new steam locomotives, and some diesel-electric locomotives are already being tried out on freight service, where the problem of train heating does not arise. It is to be noted that manufacturing facilities already available in Canada are quite competent to produce all the components of diesel-electric locomotives for road service as well as for switching. The entire ground has been carefully studied and it cannot be doubted that if and when the Canadian Railways are satisfied that they may safely turn to diesel-electric (or gas turbine-electric) traction, they will not be slow to move. The first step must be with freight traffic and in the meantime (and doubtless for a considerable time to come) the inter-city and trans-continental trains of Canada will be hauled by the large 4–6–4 and 4–8–4 type steam locomotives now in service.

(To be continued)

* See THE ENGINEER, June 10, 1949, page 644

THE MINISTER OF CIVIL AVIATION has appointed Mr. Aubrey C. Ping to the board of the British European Airways Corporation in succession to Mr. I. J. Hayward, who has resigned owing to the pressure of other duties.

Lowering of Ground Water at the South Bank Concert Hall

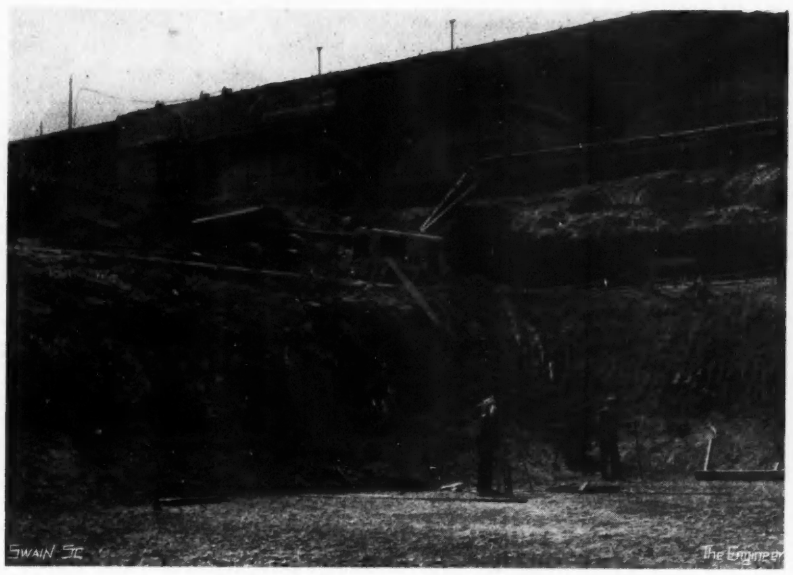
THE construction of deep foundations in water-bearing strata presents many difficulties to the engineer, and the introduction in recent years of wellpoint systems of ground water lowering has added a useful technique to the solution of such problems. An interesting example of the use of the wellpoint system is provided by the work at present in progress on the South Bank of the River Thames, where the construction of the substructure of the new Concert Hall is proceeding. The first concrete of the foundations of this structure has already been placed and excavation for the foundations is now completed. The dewatering is being carried out by Blaw Knox, Ltd., Clifton House, Euston Road, London, N.W.1.

The natural ground water level of the site averages about plus 1·5ft O.D., and the formation level is minus 11ft O.D. A lowering of ground water level over this range can be conveniently accomplished with a single-stage installation of wellpoints, the maximum suction head against which the pumps will operate usually being from approximately 16ft up to 23ft. Where the depth from normal water level to formation level is between 20ft and 30ft, it is usually possible to make a temporary set-up at normal water level and lower the water level 8ft or 9ft, at which level the main set-up of wellpoints equipment can be made. For excavations more than 30ft deep it is generally best to employ a multi-stage installation, each stage lowering the water level approximately 15ft.

Similarly, experience with this dewatering system has shown that an area up to about 200ft square can be effectively drained by lines of wellpoints round its borders, without any cross lines of wellpoints within the area itself. However, the area in the case of the Concert Hall is, very roughly, 250ft square, and it has been possible in this particular case to use simply four lines of wellpoints, one along each edge of the excavation.

Each line consists of wellpoints spaced at about 3ft intervals and connected by 1½in swinger arms to a 6in header main, and thence through a 6in centrifugal pump to the discharge pipe. Two pumps, each connected to a header line, are situated at one corner, and two at the opposite corner; a standby pump is placed at a third corner. In the event of a breakdown, the remaining pump at the affected corner can be connected to either of the header pipes which terminate at that corner, and the standby pump can then be connected to the remaining line, thus ensuring the minimum of interference to continuous pumping.

The first wellpoints were installed on the site on May 18th, and pumping started on June 19th; machine excavation of ground above normal water level was proceeding during the installation. The site has been maintained in a dry condition since pumping was started, the variations in discharge which have occurred being due mainly to the tidal influence of the River Thames. The accompanying illustrations show the condition of the site—first, when the wellpoints were being installed, but before pumping had been commenced, and secondly, with the dewatering plant functioning normally. The third illustration shows a general view of the site with the dewatering equipment in operation and part of the formation prepared for concreting. Two of the pumps can be seen at the corner of the excavation, with two lines of header pipes extending from them, and the discharge pipes running parallel with the road, above the pumps. It is of interest to note that the header pipes were installed at a level of plus 3ft O.D., which is only slightly higher than the natural ground water level, as may be seen in the first illustration. The prepared formation in the second illustration is at minus 11ft O.D., and the level of the discharge pipes from the centrifugal pumps is approximately plus 18ft O.D. The strata which are drained consist of silty clay and peat below the made ground down to about 9ft O.D., and below this level ballast to about minus 20ft O.D.



DEWATERING PLANT IN OPERATION

INSTALLATION OF WELLPOINTS

Installation of Wellpoints

The wellpoint screen section has been designed for two purposes: convenience in installation and withdrawal, and ability to remove clean filtered water from the ground. A continual removal of fine particles from the ground would be detrimental, in that it would tend to clog the plant and induce subsidences. For this reason the screen section is constructed with three layers of wire mesh consisting of a fine central mesh of 60 squares to the inch interposed between two others of coarse mesh. There is a total screened area of 300 square inches through which the ground water is drawn. A cross section of the Blaw Knox wellpoint screen section is shown in the diagram.

Installation of the wellpoint is carried out by jetting. In this system water from a jetting pump is forced down the riser pipe of the wellpoint and a ring valve fitted in the wellpoint head prevents loss of jetting pressure through the side filter. When at a later stage ground water is being drawn into the wellpoint head, a ball valve in the head prevents the ingress of solid matter from the bottom of the hole. The relative positions of these two valves during the operations of jetting and suction can be seen in the diagram.

A maximum jetting pressure of about 150 lb per square inch is used for sinking through hard gravel, but smaller pressures down to 60 lb per square inch may suffice, as the nature of

the ground dictates. Should it be necessary to sink a wellpoint through harder layers which cannot be pierced by jetting an apparatus known as a hole-puncher is employed. The hole-puncher consists of a heavy steel casing with hardened cutting teeth at the bottom and a removable head piece with hydraulic connections at the top. When heavy resistance is encountered the puncher can be jetted into the ground, and rotated back and forth through about 90 deg. with a hand lever. When it has been sunk to the required depth and the hard layer has been pierced, the head piece can be removed and the wellpoint placed inside the casing; the hole-puncher is then withdrawn leaving the wellpoint in position. Similarly, to assist in tearing through clay strata, a chain

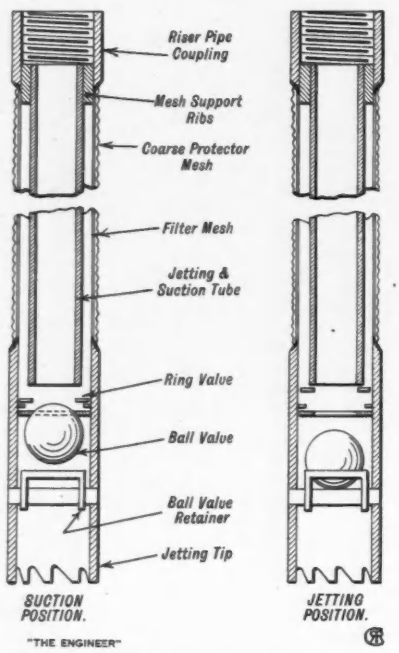


DIAGRAM OF WELLPOINT SCREEN SECTION

may be fixed round the head of the wellpoint to impart a turning movement and increase the rate of penetration.

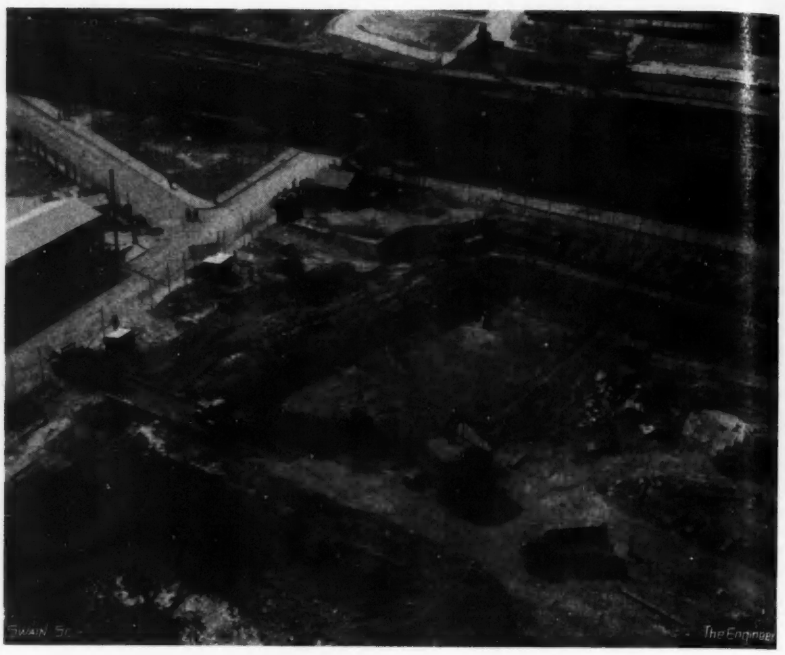
The jetting is carried out in such a manner that a cylindrical space is scoured out all round the riser pipes and wellpoint head. This space subsequently fills with coarser particles, held in suspension during jetting, and acts as an additional filter to the ground water. If impervious strata are passed through, this space is filled with sand immediately after jetting, thus providing a permeable core through which all pervious layers can be drained. Amongst other things, the speed at which the wellpoint is allowed to descend has an influence on the success of the jetting operation. When conditions are favourable wellpoints may be sunk with great rapidity. On the Concert Hall site, a maximum of fifty holes were jetted in one day by a gang of six men. On trench work it is claimed that an installation of 100ft of equipment can be maintained daily under suitable conditions.

Operation

The 6in centrifugal drainage pump is driven by a 35 h.p. diesel engine and has a maximum pumping capacity of 60,000 gallons per hour at a total head of 60ft. A device which greatly increases the efficiency of the pump is a vacuum unit for exhausting air in the system. It is seldom that water alone is drawn from the wellpoints, particularly when the yield of ground water varies, and it is necessary to exhaust a quantity of air as well. With the aid of the vacuum unit which can exhaust 62 cubic feet of free air per minute, a 25in vacuum can be maintained in the header pipes and wellpoints. The amount of air drawn off can be reduced to a minimum, however, by adjusting the cocks provided at each wellpoint swinger arm. A "hammering" effect can be detected at these points if too much air is being admitted.

The successful operation of the wellpoint system ensures that all the work for the foundations of the Concert Hall is carried out completely in the dry, the numerous disadvantages of the wet conditions normally encountered when pumping from sumps being avoided. Although no flow meters have been installed with the plant, it has been estimated that with the ground water reduced to its present level, the average hourly discharge of water is 80,000 gallons per hour, although at the commencement of pumping 150,000 gallons per hour were removed.

The consulting engineers to the London County Council for this project are Messrs. Scott and Wilson; the main contractors are Holland and Hannen and Cubitts, Ltd., and the sub-contractors for excavation are Willment Brothers, Ltd. As previously mentioned, the wellpoint installation has been installed and operated by Blaw Knox, Ltd.



GENERAL VIEW OF CONCERT HALL SITE FROM SHOT TOWER

Remodelling of Lime Street Station, Liverpool

WE have received particulars of the remodelling and resignalling work which has been carried out at Liverpool Lime Street station, on the London Midland Region of British Railways. This work, which has considerably increased the traffic capacity of the station, has involved the installation of modern all-electric signalling, the lengthening of platforms and the provision of a new turntable. Prior to the modernisation, the inadequate length of the platforms, with one or two exceptions, restricted trains running into Lime Street to twelve vehicles, and this disability was one which could not be independently dealt with owing to the position of the signalbox which was situated between the running lines. The position of the box had, without doubt, been determined by the need at the time of its construction to afford the signalmen an actual view of the running lines and platforms, but with modern apparatus and track circuit indication it has been possible to remove the signalbox clear of all running lines and use the space occupied by the original signalbox to advantage in remodelling the lay-out and the lengthening of the platforms.

The new power-worked signalbox is of the most modern design and equipped with a frame of ninety-five miniature levers. It was brought into use on January 25, 1948. Colour-light signalling, full track circuiting and train describers have been installed as between Edge Hill Station and Lime Street and block working has been dispensed with. The lengthening of the platforms and the remodelling of the permanent way lay-out enables twenty-one additional coaches to be accommodated in the station.

Civil Engineering Work

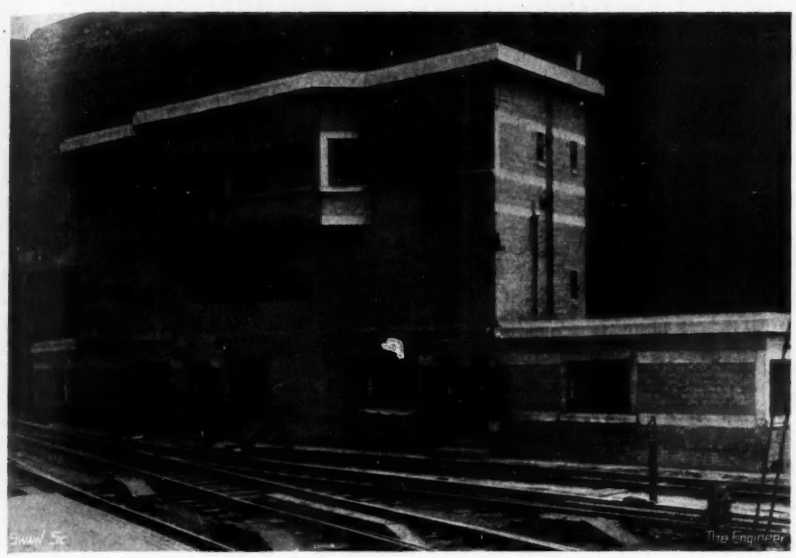
Collaboration between the civil and signal and telegraph engineers enabled a scheme to be evolved whereby the new signalling arrangements and the renewal and relaying of the permanent way could be jointly carried out by the selection of a new site for an up-to-date electrically worked signalbox and the freeing of the original signalbox site for track improvements.

The greater portion of the station and also the approach lines for the whole of their length from Edge Hill, which is 1½ miles away, were originally excavated out of solid rock to a depth of 40ft so that there was little or no space for any new works without having previously recovered some part of the original equipment. Although room was found for most of the new outside signalling equipment alongside that which already existed, large quantities of rock had to be excavated to accommodate some of the new apparatus, and for the purpose some 280 cubic yards of rock were cut out. For the installation of the new 70ft turntable it was necessary to cut out approximately 2400 cubic yards of rock and seal up fissures and cracks in the rock face and clay pockets encountered during the works.

Due to the lack of sufficient storage space the majority of the new permanent way had to be built up off the site and conveyed in com-

plete sections by working trains to the appropriate final position at Lime Street Station.

The problem facing the engineers was to accomplish the change-over and at the same time keep as much of the station as possible open to traffic. The position was considerably eased by the civil and signal and telegraph engineers having complete possession of one portion of the station for sixteen weeks. During the track renewals advantage was taken to redrain the area and at the same time the old spent ballast was removed down to the underlying rock and new ballast and drains were provided throughout.



NEW SIGNAL-BOX

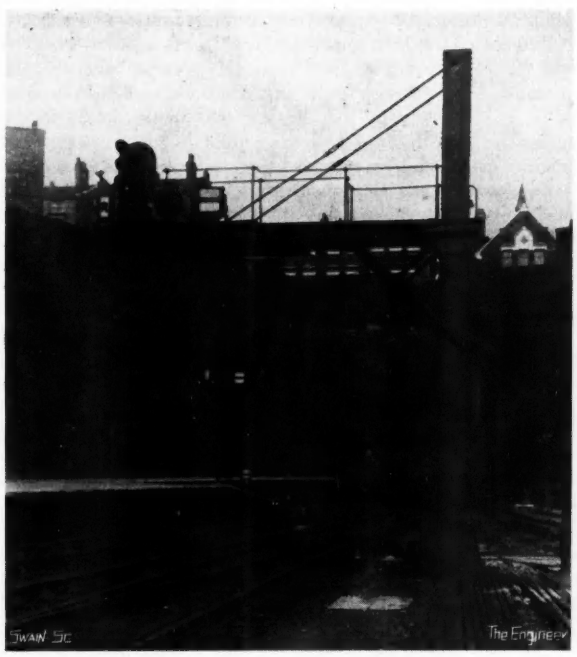
Signalling

The new signal-box, which is illustrated in one of the photographs we reproduce, is of brick and concrete construction. It has three floors; the ground-floor houses the relatively heavy electrical switchgear and 75A-h point machine battery in addition to providing messing accommodation, &c., for the shunters, and an office for their inspector. The relay room with approximately 700 relays, on the middle floor, also includes the cable terminations and all apparatus except that associated with the train describers, telephones and loudspeakers, which is housed at one end of the top floor. A ninety-five lever frame with electric inter-locking is housed on the top floor and is made up of fifty-eight signal levers, thirty-one point levers and six spare levers.

There are 250 signalled routes controlled by the frame and a somewhat unusual method of selection was employed, in order to avoid the drawbacks of excessive selection while keeping the levers within easy reach of the two signalmen who are normally on duty together.

Apart from the departure signals at the head of each platform, additional signals have had to be provided within the length of most platforms, in order to protect the connections with the sidings between adjacent platform lines and also certain connections to running lines. These connections are of necessity placed within the length of the platforms owing to the restrictions of the site. Also due to site restrictions a majority of the signals required gantry or bracket structures—there is, in fact, only one simple straight post signal on the whole scheme.

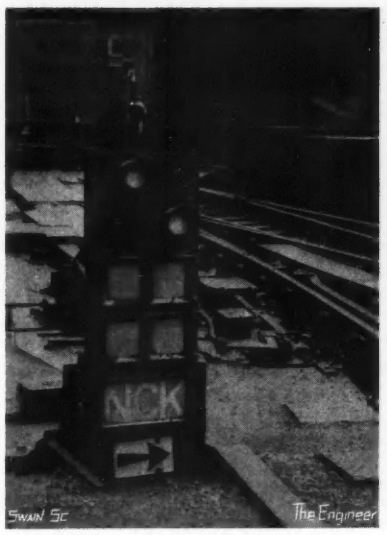
The colour-light running signals are provided with "theatre" type route indicators and position light subsidiaries (without a normal aspect) as required, while small yellow aspects are used for the "off" indications to sidings and other non-track circuited lines. Position light ground signals, which have a red and a white light for the "on" aspect, control the frequent shunting. Where these signlas are passed in the facing direction by a running movement, they are automatically taken off when a lever for the latter is reversed, and are then held off by the appropriate route relay.



PLATFORM STARTING SIGNAL WITH "R" EXHIBITED

The main and subsidiary aspects of running signals are in general controlled by the one lever and are selected according to the track circuit conditions ahead. In certain cases the subsidiary signals are used for shunting purposes only and for these cases separate levers are provided. Ground signals have not been provided for local shunts from platform lines to the adjacent sidings, but the shunters in charge of such movements are required to observe a bulkhead light which is attached to the platform wall adjacent to the points and which is illuminated when the point lever is either fully normal or reverse in the lever frame.

Certain of the departure signals at the platform ends are provided with back indicators to cater for specially long trains. These display the word "off," together with a route letter,



POSITION LIGHT GROUND SIGNAL WITH STENCIL ROUTE INDICATOR

on stencil type indicators when a running aspect has been cleared. On platforms where the driver has difficulty in seeing the guard's hand signal, "right-away" indicators have been provided below the platform departure signals. As can be seen in one of the accompanying illustrations, these signals show a black letter "R" on an illuminated background and are operated by plunger from the head of the platform in question. A white light is provided adjacent to each plunger to show when the departure signal is "off" as the indicators can only be operated under these conditions.

The track circuits are a.c. condenser fed, and electrical depression bars operate in conjunction where necessary. Outside location cupboards could not be entirely eliminated in the resignalling scheme, and, owing to the restrictions of the site, many special arrangements had to be made. Each location has a plug point for a portable telephone on a common circuit to the relay room and signalman.

The lever frame of the signalbox was supplied and installed by the Westinghouse Brake and Signal Company, Ltd., the train describers by Standard Telephones and Cables, Ltd., and the diesel alternator (for signal power supplies) by Ruston and Hornsby, Ltd. The main portion of the signalling work was carried out by what are now the London Midland Region staff of the Railway Executive. The whole of the permanent way work was carried out by London Midland Region staff under the direction of Mr. W. K. Wallace, lately civil engineer, and under the immediate supervision of Mr. W. H. Gyles, district engineer, Liverpool. The signalling work was installed under the direction of Mr. W. Wood, who was signal and telegraph engineer at the time, the work being under the immediate supervision of Mr. H. E. Morgan, lately divisional signal and telegraph engineer, Crewe.

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NOTICE TO READERS

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BRITISH RAILWAYS

ADDRESSING the Socialist Party Conference at Blackpool on June 8th, the Lord President of the Council is reported to have remarked that "The more public concerns instead of capitalist concerns become the order of the day, the more we need a lively, thrusting enterprise running right through Socialist industries from top to bottom. Socialism is not a society of slothfulness and laziness, but of life, of vitality, of liveliness and individual effort." Those are propositions with which no sensible man is likely to disagree. It was "lively, thrusting enterprise" that created and built up the industries of this country. Those industries will only persist by the continued exercise of the same faculty plus that "individual effort" which Mr. Morrison named as one of the four ingredients of socialism. It is, of course, an ingredient of human nature at large rather than of any political party, an ingredient the encouragement of which should be an obligation binding on all governments.

These observations are suggested by an article which is printed elsewhere, in this issue, wherein the writer describes certain features of railway equipment in the United States, where "public concerns" have not yet become the order of the day, and where "lively, thrusting enterprise" has helped to produce the most powerful and prosperous nation on earth. In writing this we take no political sides and we realise that the time has not yet arrived for determining what are the advantages (or the drawbacks) of railways run as "public" concerns rather than as "capitalist" concerns. We regard railways as non-political undertakings important to the entire community, and if they can prove more advantageous to the community when run as public concerns, then that is how they should be run. It would certainly be agreed that what Mr. Morrison describes as "a lively, thrusting enterprise" should characterise the railway administration from top to bottom and that "individual effort" should be encouraged to the utmost. In the United States there has been a notable demonstration of the avidity with which the privately-owned railways have risen to the occasion. Faced with severe competition from other means of transport they have lifted the conception of passenger train accommodation to a level never before seen. They have done this at enormous cost to themselves while continuing to pay taxes into the national exchequer. They have also tackled the freight business—on which their revenue mainly depends—and done all in their power to perform the duties of carriers in such a way as to assist industry. The effect of these efforts is seen not only in benefits to the travelling public and to the industries requiring transport, but in wide benefits to that section of the population which manufactures railway equipment, a section touching, more or less, the whole of the industrial activity of the United States.

Our contributor has quoted some remarks by the president of the Gulf, Mobile and Ohio Railroad which illustrate very well the width of view taken by responsible railway executives in the United States: "If," said Mr. Tigrett, "we were freed from the obligation to run any passenger trains, our financial condition would be much improved." He went on to observe that "the mere fact that a railroad loses money on a particular service is not necessarily justification for eliminating it. The real need of the public must be met even at a loss, provided the loss does not jeopardise the permanent stability of the Company which sustains it." This strikes us as conveying a truly social conception and our contributor also recalls how Mr. Faricy, president of the association of American Railroads, has stated recently that "there never has been and never will be a ceiling on improvements in railroad operation and services." Mr. Morrison could not have better examples of that "lively, thrusting enterprise," which he wishes to see "running right through socialist industries from top to bottom." It is already—as it has been for so long—running right through those "capitalist concerns" which operate the railroads of the United States. As engineers, we must all realise that any machine (or any political procedure whether socialist or capitalist) which does not develop useful energy should be scrapped. Mr. Morrison is right in earnestly preaching, as he did, the need for individual effort, but conditions must be such as to promote it. It cannot be promoted by Acts of Parliament or of Congress. It only grows by wide-spread realisation that everything depends, in the long run, on our individual exertions. Effort in the right direction, and this applies to workers, managements and politicians alike, is a plain obligation to everybody. Over a century ago, a distinguished foreign visitor to Great Britain remarked that "Solvency is in the ideas and mechanism of an Englishman. The Crystal Palace is not considered honest until it pays." If our British Railways are to be solvent it can only be managed by the unfettered exercise of initiative and industry, in the promotion of which imagination, opportunity and incentive are major ingredients. We need that "thrusting enterprise" enjoined by Mr Morrison, without which the railroads must wither. It is not only nationalisation that is on trial: what is also on trial is the capacity of the Executive to exercise the faculties of initiative and enthusiasm and to propagate them throughout the entire organisation.

THE T.U.C. AND DOLLARS

NEXT month the Trades Union Congress will meet at Bridlington to discuss its affairs and its policies. This year's conference bids fair to be very similar to its predecessors. There will be resolutions to be discussed demanding the nationalisation of this industry or that, including one supported by the Amalgamated Union of Foundry Workers for the main sections of engineering and founding. The education of trades unionists in the techniques of management will be urged. Conditions of work will be discussed. Further resolutions will seek price reductions by control and a reduction of profits. It is certain, too, that there will be the now customary resolutions for debate asking that workers be favoured against the rest of the community by such means as a lesser taxation of lower income groups or by the extension of cost-of-living subsidies. The people of this country are now well accustomed to hearing about such debates at the Congress. They know that it does not necessarily follow, because impracticable resolutions are seriously discussed, that trade union policy in the following twelve months will be equally wrong-headed. It is realised, in fact, that the Congress is held, partly at least, to allow members to give their views an airing and to permit aspirations, however impossible or undesirable, to be given voice. It is from the views expressed by the General Council, rather than from those expressed in the debates, that the British public expects to learn what trades unionism is really thinking and what line of action it is likely to favour in the future. But what, we wonder, do other nations make of these debates?

In the same month that the T.U.C. meets at Bridlington there will take place a series of important conferences affecting this country's future. They will be held in the United States, and Sir Stafford Cripps will be there endeavouring to solve the problem of Britain's serious and growing shortage of dollars. The two events are, of course, wholly disconnected. Yet the proceedings at Bridlington may well exert some influence upon Sir Stafford's mission. They may make it simpler or more difficult. Sir Stafford, we may feel assured, will enter upon his conferences with a very lively sense of the realities of the economic situation. But will the Trades Union Congress? To judge by

the programme of the latter, there is very little indication that it will. For though the leaders of the unions have accepted, albeit reluctantly, the need to "restrain a general increase of personal incomes and expenditure unrelated to higher productivity," they have, pressed on, no doubt, by their followers, actively pursued much the same ends through demands for price reductions, lower taxation of workers, increased cost-of-living subsidies and reduced profits. Moreover, as though unaware of any danger from the economic situation, the Council intends to put before the meeting a resolution, certain to be adopted, rejecting "proposals which would lower wages, lengthen hours and contract social services." The Congress, in fact, is to be held in a purely insular atmosphere, as though events beyond the boundaries of this country could have no influence on trade union affairs. An impression is gained from the draft programme of a complete absence of recognition of the fact that, should Sir Stafford's mission fail, should Britain become unable to buy food and raw materials in dollar markets, mass unemployment must reappear in this country and the standard of living must inevitably drop to a very much lower level than that now ruling. Nor could strikes, nor resolutions against lower wages and longer hours of work, nor demands for lower profits, lower prices and better social services do anything to avert that consequence.

In the longer run and over a term of years it is certain that Britain's dollar difficulties can be overcome. The solution, we hope, will be found by the United States. For we believe that, were that country to adopt "free trade" and actively encourage imports in sufficient quantity to balance its exports, the need for further Marshall aid would soon pass. But if Americans cannot be convinced that such a policy is the right one to pursue—American manufacturers would certainly view with concern oversea competition in what has been for very many years a protected home market—there is still the course open to Britain to reduce steadily her purchases from the U.S.A. until the dollar account balances. That course is already being forced on Britain. But it is not one that can be adopted at once. Time must be allowed for the development elsewhere than in "dollar" areas of sources for the production of necessary foods and raw materials. Thus, though in the longer run a solution can be seen to Britain's dollar difficulties, in the shorter run it is very necessary that Sir Stafford shall convince Americans, who have recently become vocally critical of Britain's policies, that ours is a country still worthy of continued assistance. But his task, we fear, will be made none the easier if resolutions are passed at the T.U. Congress which will seem to Americans to be asking them to support social policies of which they disapprove. Nor will matters be made any the better if delegates to that Congress appear, as, we fear, it is very likely they will appear, wholly ignorant of the fact that it is Marshall aid that is supporting a tolerable standard of living in this country.

Turin Motor Show.—It is announced that the International Motor Show at Turin will be held from May 4 to 14, 1950.

Obituary

ALFRED LAIRD HARVEY

It is with deep regret that we have to record the sudden death at his home in Newcastle-upon-Tyne on Sunday, July 24th, of Mr. Alfred Laird Harvey, the Chief Engineer to the Tyne Improvement Commission. Mr. Harvey, who, at the time of his death, was only fifty-one years of age, was a son of the late Mr. Eustace J. Harvey, of the Royal Courts of Justice, and was educated at Marlborough, where he gained the distinction of Modern Language Prizeman. During the 1914–18 war, he served in the Royal Engineers and was awarded the Military Cross. On demobilisation he went up to Cambridge, and studied at Gonville and Caius College, gaining his B.A. degree in 1921 in the Mechanical Science Tripos.

He began his civil engineering career in Canada, where he was a pupil with the late Mr. A. D. Smith, M.I.C.E., a consulting engineer. He became Mr. Smith's assistant in 1925, and was engaged on the Vancouver Harbour improvement and St. John's, Newfoundland, harbour scheme. In 1927 he came back to London and worked with Messrs. Rendel, Palmer and Tritton on London Dock schemes, and the Haifa Harbour project. In 1929 Mr. Smith invited Mr. Harvey to return to Canada and take up the position of resident engineer for his scheme for the Saguenay River dock and harbour improvements. On the completion of that work, Mr. Harvey again returned to England and was engaged from 1932 onwards on work at Shoreham and Southwick in connection with harbour improvements. He spent some time from 1935 onwards with Messrs. Alexander Gibb and Partners, on the Guinness factory at Park Royal, and later was the resident engineer for the L.C.C. Northern Outfall Works at Beckton.

In 1938 Mr. Harvey was appointed Chief Assistant Engineer to the Tyne Improvement Commission, under the late Mr. R. F. Hindmarsh, M.I.C.E., whom he succeeded as Chief Engineer on Mr. Hindmarsh's retirement in 1947. In his early work Mr. Harvey was intimately associated with the design and construction of two new quays at Tyne Dock for ocean-going vessels, and the underwater repairs to two large coal staiths.

He was a valued member of the Institution of Civil Engineers, and in 1949 to 1950 he served as chairman of the Institution's Newcastle-on-Tyne and District Association. He was awarded a Telford Premium for his 1945 paper on "Two Tyne Dock Quays at South Shields." Mr. Harvey was also a member of the American Society of Civil Engineers and the Société des Ingénieurs Civils de France. He will long be remembered as a hard-working and conscientious civil engineer, retiring by nature, but possessing considerable personal charm, and his death at a comparatively early age will be widely regretted.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

LOCOMOTIVE INTERCHANGE TRIALS

Sir,—May I be permitted to comment on Mr. F. A. S. Brown's letter in your issue of August 5th concerning the 1948 locomotive exchanges?

It is most unlikely that "streamlining" would have any appreciable influence on coal consumption at the speeds prevailing in these trials; but this apart, it is a well-known principle of scientific experiment that the effect of any particular factor can be measured only if other relevant factors can be kept constant or can at least be allowed for with something approaching accuracy. Surely, therefore, it is futile to suggest "streamlining" as a paramount factor in determining coal consumption when the participants in the trials varied so greatly in other important features of design? Moreover, a comparison between the "A 4s" and the Peppercorn "A 1s" would be of little value in this respect, since the two types differ notably in boiler and firebox proportions as well as in front end lay-out.

In view of other claims made from time to time in favour of "streamlining," perhaps it is worth while pointing out that only the former L.M.S. have ever been in a position to carry out a true practical assessment of its value in British operating conditions, since they alone have built locomotives identical in all essential respects apart from the presence or absence of the "streamline" casing. The result has been the abandonment of "streamlining."

As regards the mechanical features of the Eastern Region "A 1s" and "A 4s" it should be remembered that although the latter were unfortunate with their three failures during the trials, these locomotives have for many years performed with consistency and reliability on their own system, on turns much more exacting than those of the 1948 tests. The Eastern Region, with considerable fleets of both types now in regular service, will have no difficulty in deciding which lay-out is in the long run preferable.

S. Ellingworth, M.Sc.

Wilmslow, Cheshire, August 8th.

European Recovery Programme Electricity Report

The Organisation for European Economic Co-operation has published a report dealing with problems relating to the increase and co-ordination of the production of electricity among the participating countries. It is now available at the Stationery Office, price 1s. It deals with the shortage of power and problems of carrying out the recovery programme, and there are appendices giving an estimate of the power deficit, the production capacities and lists of power stations, and a summary of the national recovery programmes of the different countries. During the pre-war years the electricity industry in Europe went through a phase of development and concentration, but during the war production capacity decreased and work ceased on the construction of new power stations. Since the war the demand has increased, and every country is faced with a serious gap between production capacity and demand. The additional power required by the middle of 1952 is estimated at 20 million kW. The total new construction under national programmes will, it is expected, leave a deficit of some 4 to 5 million kW capacity, or about 16,600 million kWh. In addition to national power stations the construction of certain international power stations is contemplated. A contemporary programme consists of stations which individual countries consider essential to their development, but which probably they will not be able to complete, without financial assistance. The power plants planned under the national and international programmes will possess a total capacity of about 7·8 million kW, with an output of 28·2 million kWh at a cost of 1949 million dollars. It is anticipated that it will be necessary to continue restrictions in consumption, in order to avoid interference with industrial production. There also exists a comparative shortage of transmission lines capacity, particularly with regard to interconnections through frontiers. Co-ordination for the improved utilisation of generating facilities and power resources is being implemented through the Electric Energy Committee of the Economic Commission for Europe and by means of bilateral agreements. In general, it is pointed out, the cost of electricity production is covered by the prices charged to consumers, but the cost of replacement and new construction requires considerable investment of new capital over a long-term period.

Literature

Electrical Timekeeping. Second edition. By F. HOPE-JONES. London: N. A. G. Press, Ltd., 225, Latymer Court, W.6. Price 21s. net.

THIS book is the work of one who can speak with authority on the subject, and has himself made considerable contributions to the efficiency of electrical horology, and so is worthy of careful study.

Although it is a second edition of a work originally published about nine years ago, it has been carefully revised, and brought up to date, and includes every important aspect of recent developments. This has been done without any deletion of the account of the work of early experimenters, which was featured in the first edition, but some parts of these chapters, which were considered capable of improvement, have been modified.

In his survey, Mr. Hope-Jones is very able in the way he indicates sound and fallacious principles, and he shows the remarkable extent to which many factors of importance were ignored by many who attempted to construct accurate electric clocks. Even more interesting is his comment that now, when correct principles have been firmly established, inventors still put forward schemes that are fundamentally incorrect.

In the first edition the illustrations were not in uniform style, but this has now been corrected. Almost every diagram has been redrawn, and a number of new ones have been added. In some cases, the viewpoint has been altered to improve clarity.

The chapters dealing with the Shortt-Synchronome "Free Pendulum" are particularly comprehensive. This form of timekeeper still remains the most accurate pendulum clock in existence, and is one of the most remarkable technical achievements. The details of its construction and performance, which are covered in Chapters XVI to XXII provide most interesting reading.

A new development in horology dealt with in the second edition is the Horstmann-Clifford magnetic escapement. The principles are distinctly novel, and this book makes the device clear and understandable. As it seems likely that the escapement will be entering upon commercial production in the near future, this account should be valuable.

The chapters of the book which deal with frequency-controlled timekeeping, synchronous clocks, and timekeeping at sea, have all been revised, and this is to be expected in these fields of horology, which are still subject to constant improvement. The chapters contain practically every detail of importance.

An additional chapter deals with the quartz crystal clock. The principles involved in this are somewhat complex, but the author has given a very concise account and has made it fairly simple to follow the action of the components and assemblies.

The glossary and index have been retained and brought up to date, and a list of Shortt-Synchronome free-pendulum clocks with their locations has been added. There are several new plates, mostly portraits of notable inventors in the field of electrical horology, and there is an improved view of the mechanism of a free-pendulum clock.

Type face, paper and binding are all good, and, as a reference work and textbook, "Electrical Timekeeping" is very sound and should help considerably towards a better understanding of the subject it describes.

Helical Gears Cut on "Solid Table" Machines

No. III—DISTRIBUTION AND AMOUNT OF ERRORS*

By S. A. COULING, M.I.Mech.E. A.M.I.C.E. †

IN previous articles consideration has been given to the limitations and errors caused in tooth wheel production by the indexing element of a gear hobbing machine and also by the cutting hob. This article first deals with a further source of error in gear cutting and then describes a new machine, recently installed, which was designed to a specification based upon the knowledge disclosed in this and the previous articles and to overcome the various errors as far as possible.

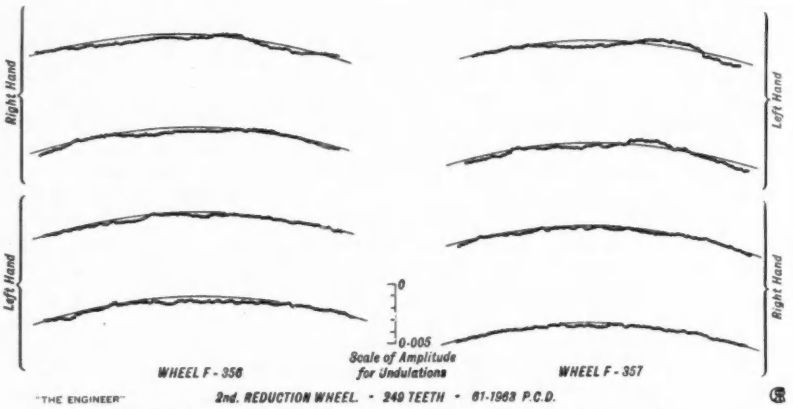


FIG. 15—UNDULATION RECORD ALONG FACE OF GEAR WHEEL

INACCURACIES IN HELICAL ANGLES

When cutting helical gears another matter of importance is the matching of the driving and driven helices. Although the angle is of equal value for a pinion and wheel combination, the hand is of opposite sense, necessitating opposite directions of machine table rotation for each hand of helix. Further, due to the tiring of the cutting edge of the hob, the tooth tends to thicken towards the end of the hob travel and so introduce an angle error. For this reason a very fine finishing cut is used.

The normal method of producing the helical angle is to set up the machine indexing as for cutting a straight spur wheel and superimposing on the rotational motion of the machine table an increase or decrease of rotation, by means of a train of gears and a differential. This increase or decrease is proportional to the increment of lead per revolution of machine table and corresponding feed of the hob saddle. These combine to make the production of matching angles on an engaging pair of gears difficult and, additionally, any relative change of temperature occurring during the cutting of the complete face width makes the task of a perfect match impossible. Early experience with these difficulties led to the experiment of cutting the helices without the use of the differential.

The indexing gears on the hobbing machine are set up for the number of teeth in the gear wheel to be cut plus the increment of helical lead per down feed of hob saddle corresponding to one revolution of the table. By this method a train of seventeen gear wheels is eliminated and the error in the helical angle is now only dependent upon the lead screw and saddle guides. Further, when using the same machine for cutting pinions and wheels, any departure from the nominal helical angle in either element due to wear in the nut or the lead screw will be compensated for automatically by using the same position of the screw; the angles must in consequence match apart from temperature effects. The indexing and feed change gear formulæ are also simplified to:—

$$\text{Index:} \quad \frac{K}{N-\frac{F}{AP}}.$$

$$\text{Feed:} \quad K \times F$$

when K = constant for the machine,
N = number of teeth to be cut,
F = feed,
AP = axial pitch.

By way of interest it is worth recording that a check on a 6in diameter pinion with thirty-three teeth, ½in normal pitch, 30 deg. helical angle and cut non-differentially, the average error over the whole face width, checking each tooth, was −0·000133in around the periphery and this, in spite of the

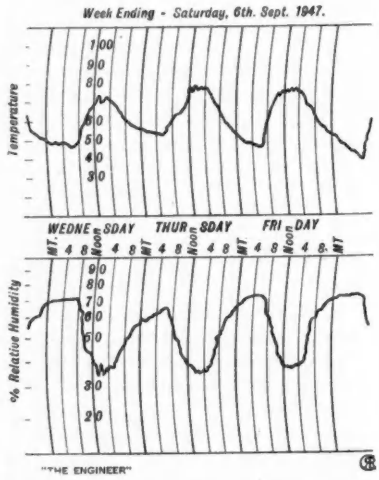


FIG. 16—NIGHT AND DAY TEMPERATURE VARIATIONS

* Part II appeared May 27, 1949, page 580.

† Chief gear engineer, the British Thomson-Houston Company, Ltd.

fact that the machine had been in constant use for twenty-two years.

The Effect of Temperature Change

The effect of temperature is dependent upon the time taken to cut down the face width of the gear and the atmospheric change during that time. The time taken to cut may amount to several days' and nights' continuous cutting, and not only may the temperature change between day and night, but also between starting and finishing a face. Fig. 15 shows the undulation record along the face of a gear wheel, 60in diameter, 11in face width, and using the Tomlinson recorder. The time taken to cut each face was seventy hours approximately, and the diametral expansion for 1 deg. Fah. is equal to 0·00038in. It will be noted from Fig. 15 that there is a diametral error of approximately ±0·0004in radially from the true pitch circle diameter, equivalent to a change of about 4 deg. Fah. during cutting. Very seldom is there less than 4 deg. Fah. change in every twenty-four hours, and from tests taken on a machine during cutting there is seldom less than this difference registered between the machine column, its bed and the gear wheel rim. During exceptionally hot or cold spells the difference can be as much as 16 deg. to 20 deg. Fah. between night and day temperatures. Fig. 16 was recorded on the site of the gear hobbing machine in an enclosed housing and represents shade atmospheric temperature.

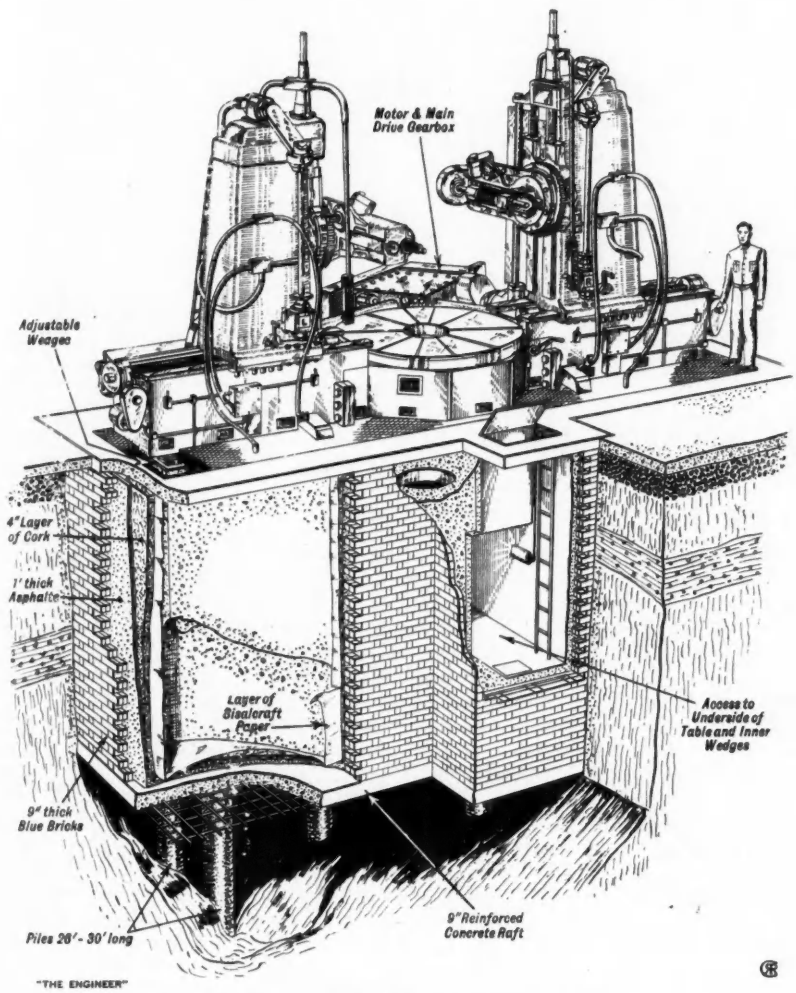

Motor & Main Drive Gearbox
Adjustable Wedges
4" Layer of Cork
1" thick Asphalte
Layer of Sisalcraft Paper
9" thick Blue Bricks
Piles 26'- 30' long
9" Reinforced Concrete Raft
Access to Underside of Table and Inner Wedges
"THE ENGINEER"

FIG. 17—GOULD AND EBERHARDT HOBBING MACHINE

New Machine Incorporating Multi-Toothed Worm Wheel and Arranged for "Non-Differential" Angle Cutting

As explained in the first article, decrease in form error, &c., can be expected with the increase of the number of teeth in the indexing wheel of the hobbing machine. Commencing with 120 teeth on a 60in pitch circle diameter worm wheel, the teeth were increased stage by stage and finally on the same diameter a wheel was cut with 600 teeth. The expectations of the advantage by this procedure were fully justified by experience, and these developments were published in the Institution of Mechanical Engineers *Journal*, Vol. 150, No. 5.

At about this time a new machine was ordered as indicated above and having 720 teeth on a 96in diameter worm wheel with the hope that more evidence of the advantage of a multi-tooth worm wheel would become available. Unfortunately, the war resulted in the machine being diverted to the U.S.A. and developments had to be postponed for the time being. In 1945 the need for new machines to replace the existing ones became so urgent that two machines were ordered, one from the U.S.A. and one from this country, each incorporating the special features already advanced. Fig. 17 shows the American machine which was manufactured by the Gould and Eberhardt Company, Newark, New Jersey. It has two dividing wheels, 96in diameter, one having 720 teeth and the other 960 teeth, and is capable of cutting helical gear wheels up to 120in diameter, with 45 deg. helical angle and a face width of about 36in. The table is located by a 48in diameter taper roller bearing and is supported by two parallel tracks divided by an annular space for an oil supply at the desired pressure. The load on these tracks is kept at a constant specific pressure independent of the weight of the gear wheel on the machine table. The machine is housed in a special cubicle, which is kept at a constant temperature of 70 deg. Fah. and is supported on special foundations, which are clearly indicated in Fig. 17.

Foundations

Great care was taken with the foundations to make them as solid as possible and to be insulated from vibrations in any direction. It should be noted that reinforced piles were driven to a depth of about 50ft, and on the top of these a reinforced concrete raft was cast, the irons from the concrete piles being woven into the reinforcement in the raft. A brick wall to a depth of 18ft encloses a

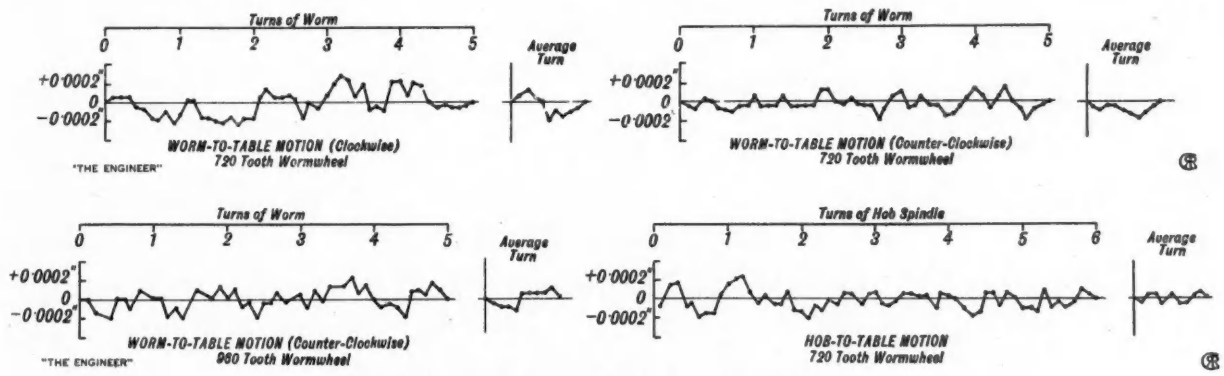


FIG. 18—WORM-TO-TABLE AND HOB-TO-TABLE ACCURACY

volume of concrete, upon the top of which is mounted the machine. On the top of the raft and the sides of the retaining walls, following a coating of bitumen and sisalkraft paper, is a cork mat, 4in thick, completely insulating the concrete base from its surroundings.

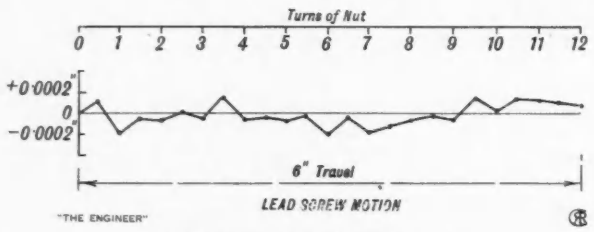


FIG. 19—LEAD SCREW ACCURACY

CHECKING AND TESTING THE NEW MACHINE

Preliminary checks of the machine were made at the maker's works sufficient to promise ultimate compliance with the original specification. It was early appreciated that final checks would have to be made in the temperature-controlled cubicle. Special technique has had to be developed to be able to read the very small differences in dimensional readings obtained during check tests. For example, using a steel point on a needle and a smoked glass as a recording tablet, it was found that the thinnest line was of the order of 0·0003in, whereas the average differences disclosed were of the order of 0·0001in. To guarantee this figure it is necessary to measure as small as 0·00005in, which becomes absurd in a machine as large as the one under review. Further, without temperature control, such small differences become impossible of absolute accuracy. Even with temperature control difficulties are plentiful.

Altogether over 3000 readings have been made and in most cases repeated independent tabulations were averaged for final graph purposes. Where possible, more than one method of checking has been resorted to so as to be as sure as possible of conclusions and some previously established methods of checking had to be abandoned. For example, a "tenth-clock" recorded no worm end-float when the machine was completely erected. By rigging up a mirror and auto-collimator and multiplying the error, a reading of approximately 0·000075in was obtained per revolution of the worm, and since we believe the results of the checks will be of wide interest, we detail below some of the more important ones.

WORM-TO-TABLE AND HOB-TO-TABLE ACCURACY

The N.P.L. methods of checking were used for worm-to-table motion and, as explained above, difficulties were experienced to obtain constant results. Fig. 18 shows typical results of this type of test. The average errors are exceedingly small and even random errors are well inside the "A" limits of B.S.S. 1498. The method finally adopted was to take four sets of repeat readings at points 0 deg., 90 deg., 180 deg., &c., around the table, for each direction of rotation and for each of the worm wheels. The same methods were used to obtain the relative hob saddle-to-table motion, and, if anything, the inaccuracies were less than the worm-to-table readings. The result (Fig. 18) is typical and again the Grade "A" limits are easily beaten. In fact, some of the limits make the specification look coarse by comparison, especially Grade "B." What does seem necessary at the moment is an improved method of taking these readings, as the time and labour involved is very heavy. Further, the degree of accuracy obtained with present methods can only be of the order of a 20 per cent margin when dealing with such small recorded increments.

LEAD SCREW ACCURACY

Importance is given to the lead screw, since, as mentioned above, the helical lead angle accuracy is directly dependent upon this element of the machine. Two check methods were used to obtain this characteristic. First, block gauge and clock readings for increment down feed of the hob saddle; and secondly, a device developed from the American practice of producing a check rod of the down feed with the machine in motion. A steel bar, 7in long, ¼in thick, was clamped on the table in a vertical direction, facing the hob saddle. A tungsten-tipped tool was mounted in the hob saddle and as the saddle moved downwards by a predetermined feed the tool notched the bar. To deal with the whole length of lead screw for the machine under review six notched bars are necessary for one direction of travel only, which can then be taken to a measuring microscope for checking. Fig. 19 is a typical record.

It will be noted, not only is the cyclic error small, but the cumulative error is also better than any we have so far measured. This method of checking is very simple and can be taken whilst normal cutting is in progress, and it is proposed to make this a routine practice in the future. Attempts are also being made to record the indexing motions similarly whilst cutting gear wheels by using the underneath position of the table.

To include all the checks taken, such as worm and hob rotational setting, table locating, &c., would be tedious, and it will suffice to record that in every check so far made the machine is better than our own specification and would easily pass Grade "A" of the British Standard Specification.

In conclusion, this article and the preceding ones show that the production of accurate and quiet gears does not require a post-hobbing process, but demands a machine independently installed in a temperature-controlled cubicle and having a mechanism that is simple, accurate and correctly designed.

Supervisory Control for London Transport N.E. Extension

SPEED of operation without loss of reliability is an important requirement in a supervisory system controlling the power supply to underground railways, since current failures, even of short duration, can cause serious traffic dislocation, particularly at peak periods. A supervisory system designed to satisfy this requirement has been evolved by the General Electric Company, Ltd., in co-operation with the technical staff of the London Transport Executive for service on the Central Line extension from Liverpool Street to Loughton and the Hainault Loop.

The area over which the remote supervisory control system operates contains eleven transforming, rectifying and distributing sub-stations, situated at Bethnal Green, Bow, Leyton, Leytonstone, Red Bridge, Newbury Park, Hainault, South Woodford, Roding Valley, Loughton and Epping.

The switchgear at all eleven sub-stations is arranged to be controlled from South Woodford sub-station. Control of switchgear at sub-stations other than South Woodford is effected remotely over pilot cables, whilst the switchgear at South Woodford itself is controlled directly over multi-core cables connected between a control cubicle and the sub-station switchgear. One of the accompanying illustrations gives a view of Bethnal Green sub-station, showing some of the air-break circuit breakers which are operated by the remote supervisory control system.

CONTROL EQUIPMENT

The supervisory control apparatus associated with each sub-station consists of a control cubicle installed in the control room at South Woodford, and a supervisory unit located at the sub-station. As indicated by another illustration on the opposite page, the eleven cubicles, with an additional cubicle provided for future development, are arranged in the shape of an open rectangle so that the control engineer at South Woodford can see at a glance the conditions in force on the whole system.

A control panel is fitted in the front of each cubicle, and is laid out in the form of a mimic diagram of the power network at the sub-station concerned. Keys of an illuminated handle type are employed for the control of switchgear; these keys, which provide both control and indication facilities, have materially assisted in enabling the process of opening or closing a circuit breaker to be speeded up to the very short time of two seconds. One key of this type selects and operates the remote switchgear, whereas in some earlier systems separate keys have been required for the two functions. Indication that both operations have been effected is given by the handle lamps in the new keys instead of by two separate indicator lamps. By simplifying the procedure needed for restoring a circuit breaker, a considerable cumulative gain in time is achieved when a number of breakers are involved after a power failure.

Small lamps are provided for giving indications of alarm devices and of switchgear not arranged for operation by supervisory control. Relays and selectors of conventional telephone type are mounted in the cubicle on gates which may be swung out to the rear for easy maintenance. With the gate swung out, the wiring of the control panel key spring sets and lamps becomes readily accessible from the rear of the cubicle.

FACILITIES

The supervisory control system provides the following facilities:—

(1) Control and indication of circuit breakers in 22-kV, three-phase a.c. incoming feeders.

(2) Control and indication of circuit breakers in feeders supplying steel tank rectifiers associated with the track supply.

(3) Indication of circuit breakers connecting output from rectifiers to d.c. bus-bars.

(4) Control and indication 630-V d.c. track feeder breakers. These breakers are arranged for automatic tripping from tunnel sections in an emergency; a special indication is given on the control panel, and a lock-out device prevents restoration of any breakers tripped from a tunnel until the emergency which caused the tripping has been cleared.

(5) Control and indication of contactors in the supply circuit to escalators.

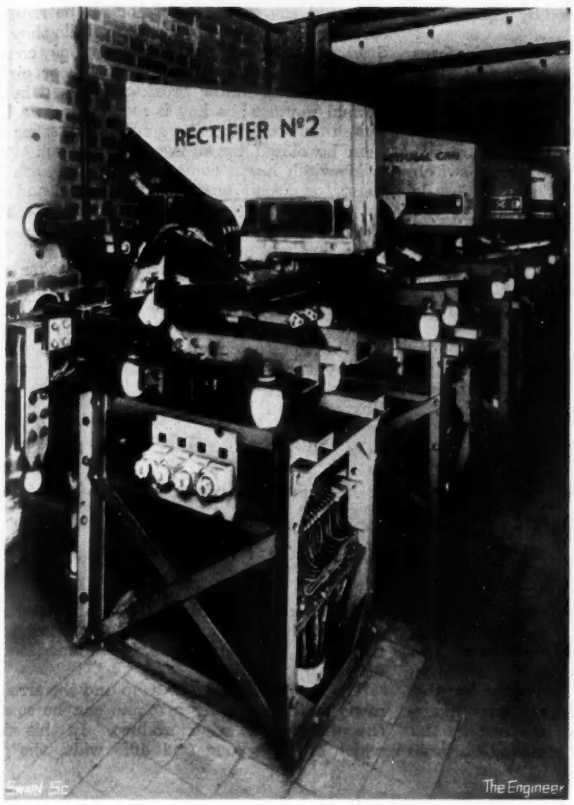
(6) Control and indication of circuit breaker in feeder to 22-kV/660-V/440-V transformer providing three-phase a.c. supply to lighting bus-bars.

(7) Control and indication of lighting feeder

breakers on low-voltage side of transformer referred to in item (6) above.

(8) Control and indication of circuit breakers in 440-V, three-phase a.c. supplies to air compressor motors.

(9) Control and indication of circuit breakers controlling motor generator sets producing 600-V, 33⅓ cycles, single-phase a.c. supply for signalling purposes.



Remote Controlled Circuit Breakers at Bethnal Green Sub-Station

(10) Control and indication of circuit breakers in the 600-V feeders mentioned in item (9) above.

(11) Indication only of contactors for control transformers.

(12) Continuous indication of the condition of the air pressure ("high," "normal" or "low") at certain sub-stations.

(13) Continuous indication of the condition of rectifier loads ("high," "normal" or "light").

(14) Special indication that the track is "alive" whenever a track feeder breaker is tripped and the associated section of track remains alive.

(15) Restoration of power to the affected section of track after "tunnel trip" conditions.

(16) "Dead" and "alive" indications in connection with 600-V a.c. signals supply bus-bars.

(17) The connection of a motor generator set to "dead" bus-bars (the M/G set normally becomes connected automatically to the bus-bars when it has run up to speed and synchronised with the bus-bars supplies).

(18) Indication of the rectifier locking out.

(19) Indication of faults which may develop on the pilot wires.

(20) Indication of power failures both at South Woodford and the sub-stations.

Additional indications are given if an alarm cycle fails due to incorrect impulsing, or a dirty auxiliary contact is encountered during the operation or indication of a circuit breaker.

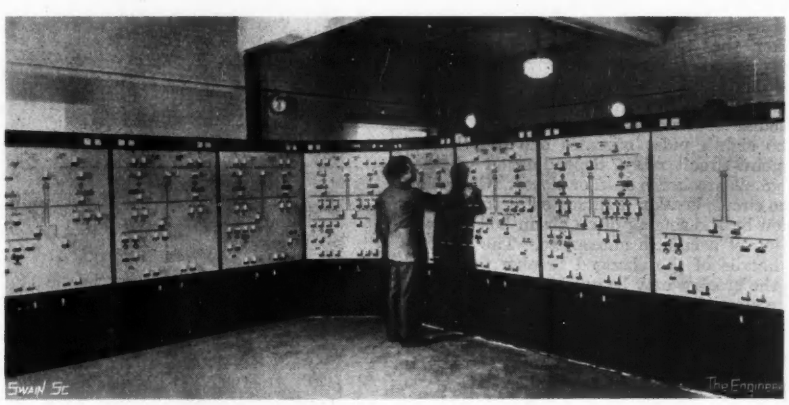
Signalling Channels

Apart from South Woodford control panel, which is connected to the local switchgear by multi-core cables, each sub-station control cubicle is joined to the supervisory unit at the respective sub-station by two pairs of pilot wires. Under normal working conditions both pairs are used for signalling. One pair carries signals for a select and operate sequence, while the other pair returns signals for alarm cycles.

In the event of one pair of pilot wires being open circuited by a fault, supervisory control and indication can be arranged immediately to function over the good pair. Under these emergency conditions there is no diminution in the facilities available, the only effect being to increase the time required to complete a series of operations, since signalling over a single pair of wires can proceed at any time in one direction only. Under normal working conditions the control station circuits are ready to receive a signal (i.e., an alarm cycle) from the sub-station. A "select-and-operate" cycle takes precedence over an alarm cycle, and any alarm cycles which may be initiated during a "select-and-operate" sequence are held up until the sequence has been completed.

Allocation of Controlled and Indicated Switchgear

One of the photographs reproduced overleaf shows the supervisory unit at Bethnal Green sub-station, which can be considered as typical of the system. At each sub-station the supervisory unit embodies three receiver selectors, which are used to select the switchgear to be controlled or indicated. Each selector has twenty-three available outlets, so that the maximum number of "points" which can be controlled and/or indicated at any one sub-station is sixty-nine. In practice, only the first twenty outlets on each selector are used. A similar allocation of selectors and division of selectors is made at the control station for working to control keys and indicator lamps.



Control Cubicles at South Woodford

Signals

Direct current pulses are transmitted in certain sequences to form codes for ensuring correct selection and operation of the switchgear. The pulses are separated by break periods of equal duration, the combined make-and-break period forming an "impulse." The pulses are either positive or negative in polarity, and the code provides a distinctive impulse for each item of switchgear.

A nine-element code is sent to a sub-station to select and operate a particular circuit breaker. The first seven pulses select the required point on one of the receiver selectors at the sub-station, and the eighth pulse determines whether the breaker is to be opened or closed. The ninth element of the code is composed of several pulses which perform various functions, the most important being the actual operation of the circuit breaker and the testing of the breaker point circuit for the new condition of the breaker.

The operation of a circuit breaker by local control, or a change of indication of air pressure, &c., causes an eight-element code (i.e., an alarm cycle) to be sent back to the control station. The first seven pulses progressively select the required point on one of the three receiving selectors at control, and the eighth pulse gives an indication of the condition of the affected item of switchgear.

Circuit Operation

Select-and-Operate Sequence : Control Station.—The control key of the circuit breaker to be operated is thrown to, and held in, one of the two non-locking positions of the key spring-sets. The lamp in the key handle is flashed and a point on one of three searcher selectors is marked. The affected selector self-drives and halts on this marked point.

A code-sender selector then begins to drive round its contact bank, and the strapping of this bank, together with connections resulting from the position of the searcher selector wipers, determines the sequence of positive and negative pulses to be sent out to line.

Select-and-Operate Sequence : Sub-Station.—The impulses are received at the sub-station by a chain of relays. Each impulse is applied to a set of three relays ; one relay operates on a positive pulse, another operates if the pulse is negative, and a third distributor relay operates during the break period of the impulse. The relays are arranged to be held operated until the "operate" sequence has completed.

The successive operation of these code-receiving relays causes one of the three receiver selectors to hunt for and halt on the point associated with the circuit breaker to be operated. The selector concerned actually drives while the code is still being received, though precautions are taken to prevent the wipers driving past the required point.

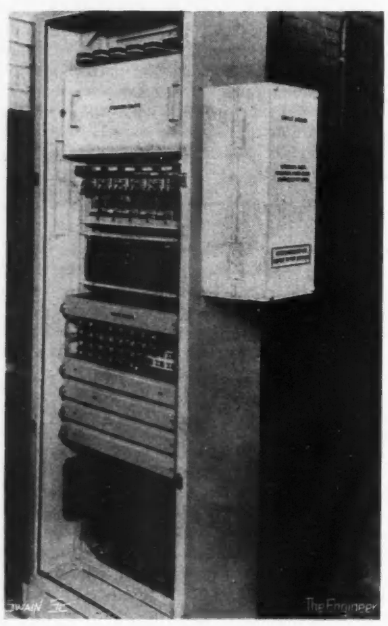
The eighth pulse prepares a circuit for the energisation of the breaker close or trip coils, and the breaker closes or opens when the ninth signal has been received. Auxiliary contacts of the breaker then cause the line to be polarised by rectifiers which allow current to flow in the line in one direction only.

At the control station two polarised relays are held operated by short positive and negative pulses being transmitted to line. When the

line is polarised by the sub-station circuits, one of these relays is released and the lamps in the control key handle glow steadily to indicate that the breaker has changed.

The control key is now released and restored to a locking "indicate" position, and the key handle lighting is extinguished. The total time taken for the operation, from the initial turning of the control key until the key handle glows steadily does not exceed two seconds.

Alarm Cycle: Sub-Station.—Operation of a circuit breaker by local control causes the change over of auxiliary contacts, which in turn initiate an alarm cycle. The subsequent circuit operation is similar to the sequence of events which takes place at the control station when a control key is turned, and a code is



Supervisory Unit at Bethnal Green Sub-Station

sent out over the second pair of pilot lines. The code is composed of eight pulses, the first seven of which are identical with the first seven pulses of the code sent out by control to select the breaker.

Alarm Cycle: Control Station.—With the arrival of the seventh pulse at the control station a receiver selector is positioned on the point associated with the point circuit of the breaker that has been changed. During the break period following the seventh pulse, a point circuit relay is released (one is normally operated to maintain an indication of the particular breaker condition).

The eighth pulse operates one or other of the point-circuit relays depending on whether the circuit breaker is open or closed. Operation of the circuit breaker is indicated at the control station by the ringing of an alarm bell and the lighting of a cubicle nameplate. The control-key handle of the changed breaker flashes so that the breaker may be quickly identified.

The alarm bell is silenced and the nameplate lamps extinguished when a common "silence bell" push button is depressed. The breaker key handle continues to flash until the key is turned to agree with the new indication.

When the audible and visible alarms have been cancelled by the "silence bell" push button following an alarm cycle, but the panel diagram has not been "dressed" to agree with the new indication, a second alarm cycle sets in operation a chain of relays which cause a single-strike bell to sound and the cubicle nameplate to flash. These alarms are automatically cancelled after a few seconds, but the affected breaker key-handle flashes until the key is turned to the correct "indicate" position.

Tunnel Trip Arrangements

On tunnel sections two bare telephone wires are run along the side of the tunnel. In an emergency, these wires may be clipped together to trip the two feeder breakers supplying the track. Visible and audible alarms are given at the control station if the wires are clipped, and the lamp lights to indicate the "tunnel trip" conditions. Each section of track is fed through two circuit breakers, and the possibility exists that one of the breakers may fail to trip when "tunnel trip" conditions are imposed. To give warning of this eventuality a red "track alive" lamp glows, whereupon the closed breaker can be tripped by supervisory control.

When tunnel trip arrangements are in force the "close/operate" function of the affected track-feeder breaker keys is rendered ineffective. Should the "tunnel trip" be caused by a fault power may be restored to the "dead" sections of track at the discretion of a responsible official by inserting a key into a lock switch fitted on the control panel. When the key is turned, the "close/operate" function of the associated breaker key is rendered effective and the track-feeder breaker can be closed by supervisory control in the normal manner.

If the key is removed from the lock before the emergency has ended, "tunnel trip" conditions in full are again imposed.

Signals Motor Generator Sets

Normal control of the motor generator sets consists of closing the motor circuit breaker by supervisory control. The machine runs up to speed and in due course the generator synchronises with the signals bus-bar. The generator circuit breaker then closes automatically. When shutting down, the motor circuit breaker is tripped by supervisory control and the generator circuit breaker opens automatically. For normal starting and shutting down, therefore, supervisory control of the generator circuit breaker is not used.

Should the motor generator set be required to be connected to the bus-bars while they are dead, use must be made of the emergency control facility associated with the generator circuit breaker. The motor breaker is closed in the normal manner; a key is inserted into a lock switch and turned; the generator breaker can then be closed by supervisory control. (The lock switch has a contact associated with the generator circuit breaker control key, and this key is not effective unless the lock has been operated.) Emergency control cannot be used if the bus-bars are alive.

Should the generator circuit breaker trip out due to overload and leave the bus-bars alive, the motor generator set should still be running. Under these circumstances reclosing of the generator circuit breaker may be carried out by turning the generator circuit breaker control key without having first operated the Yale-type lock switch.

Metal-Spraying Plant for Constructional Steelwork

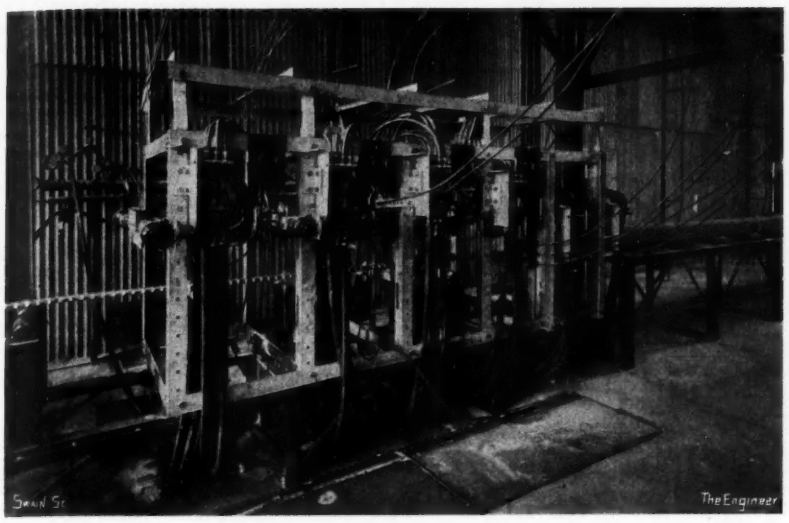
THE application of aluminium or zinc coatings on structural steelwork for protective purposes by means of metal-spraying pistols has long been a common practice, but effective though this method is it is a somewhat lengthy and expensive business when very large quantities are involved. In order to speed up the process and reduce the costs involved on large projects, an interesting new plant has been laid down at the works of Metallisation, Ltd., Pear Tree Lane, Dudley, for the continuous automatic spraying of constructional steelwork. This plant, which is adapted for applying aluminium or zinc coatings to rolled steel joists, angles, channels, &c., is stated by its designers to be the first to be made to metal-spray constructional steelwork automatically, and incorporates the largest metal-spraying machine in the world. In it the steel sections are first grit blasted and then sprayed with metal at a speed of 10ft per minute. Rolled steel joists up to 6ft by 16in can be accommodated in lengths up to 56ft.

The lay-out of the new shop and the arrangement of the spraying machine can be seen in the photographs we reproduce. In this shop, which is 120ft long and 40ft wide, the grit-blasting plant and the metal-spraying machine are arranged on each side halfway down its length. One end of the shop is open to a large stock yard, where the steelwork is handled by a 10-ton crane. This crane also serves to lift outgoing and incoming material between the yard and trucks on an adjoining railway siding.

Steelwork Spraying Shop

Steel sections entering the plant are first placed on a roller conveyor leading to the grit-blasting machine. The rolls of this conveyor are spaced at 4ft centres and are driven by a

roller chain at a speed of 4ft per minute. The shot-blasting machine is a specially designed "Wheelabrator," built by Tilghman's Patent Sand Blast Company, Ltd. It is equipped with four wheels so arranged to ensure complete cleaning of all faces of angles, joists, &c., in one pass. It is general practice to pass two or more sections at a time through this machine. When the sections emerge from the far end of the shot blast they are carried on the roller conveyor to the innermost end of the shop, where they are removed by a 1-ton overhead hoist. The cleaned sections are either stacked on the floor or transferred directly over to a roller conveyor which feeds the spraying machine.

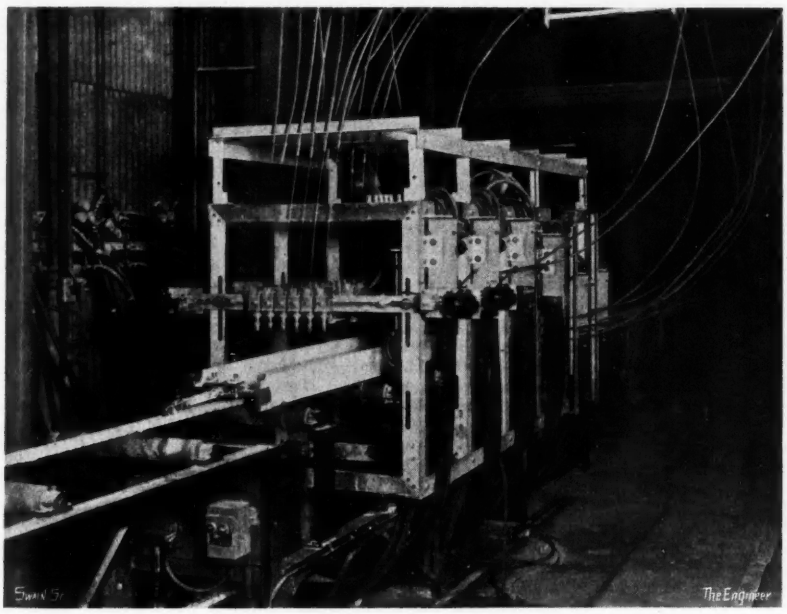


STEELWORK SPRAYING MACHINE

The spraying machine conveyor has idler rollers and the steelwork is drawn through the machine by an endless roller chain driven through reduction gearing by a variable-speed motor. The sections are locked on the chain by means of dogs.

The spraying machine, as can be seen from our illustrations, consists of a simple angle iron framework which encloses the conveyor and supports the pistols. The spraying nozzles or heads are based on the firm's standard wire feed pistol, and each head is designed to apply a coating over an area 1½in wide. The setting of the heads is so arranged that there is a slight overlapping of the area sprayed to ensure that all parts of the steelwork are completely covered. The heads are arranged in groups of three, and are fed with gas, air and oxygen from a common manifold, each group being driven by its own electric motor. Wire is supplied to the pistols from large reels situated on a platform above the machine. The wires are conveyed to the pistols through copper tubing arranged between the reel platform and the supporting framework.

It will be appreciated that the arrangements and number of pistols used to spray the metal coating are decided upon in accordance with the size and shape of the steelwork section. Up to twenty-six metal-spraying heads can be fitted on the machine. In the case of the rolled steel joist being sprayed on the machine shown in the illustration two passes are made. In the first pass the top of one flange, its inner face, one side of the web and the inner face of the opposite flange are sprayed. At the conclusion of the pass the joist is transferred from the conveyor to a truck by means of an overhead hoist and taken back to the feed end of the conveyor. Here the joist is turned over to expose the unsprayed surfaces and recoupled to the conveyor chain to be drawn through the machine again. On such a joist the head or nozzle sequence is as follows:—First, two sets of three heads arranged horizontally spray the top of the flange; then a group of three heads inclined at an angle spray the inside of the flange after which a second group of three inclined heads spray the inside face of the opposite flange; the top face of the web is then sprayed by two vertical groups of six heads. The heads are pitched at 2½in centres on their manifolds and the duplicated vertical and horizontal groups of heads are staggered to ensure that the 1½in diameter sprays of metal they project overlap on the steelwork. According to the width of the flange and the depth of the web of the steelwork heads are brought into or taken out of service. Adjustable guide rings on the rollers immediately before and through the machine are set to guide the steelwork in respect to the heads.



JOIST BEING SPRAYED WITH ALUMINIUM

The spraying head manifolds and drives are mounted in slots in the framework of the machine, and have a wide range of adjustment in order that a variety of sizes and sections can be handled. The manifolds are connected by flexible tubing to the main service piping on the side wall of the shops and do not in any way obstruct the view of the operator when the machine is at work. A large exhaust fan outside the building is connected by underground ducting to the machine and serves to prevent a large proportion of the free metal dust contaminating the surrounding atmosphere.

The thickness of metal deposited by the machine is set by the speed at which the steelwork is pulled through on the conveyor, and normally each head sprays from 4½ lb to 5 lb of aluminium per hour to give a coating 0·004in thick. Aluminium can be deposited at a rate of 112 lb per hour or zinc at 450 lb per hour. When necessary sheet metal masks can be easily clipped on any part of the steelwork where it is specified that no coating is required.

A Canteen Staff Training Centre

A TRAINING centre for canteen staff which has been opened by London Transport next to Baker Street Station is believed to be the first centre of its kind run by an industrial organisation. The Baker Street site was chosen both because of its central position and its proximity to an important interchange station where a staff canteen was needed, and an modern canteen has been incorporated in the scheme.

The centre occupies the entire first floor of a new building. It is in two main divisions—a general demonstration kitchen and a pastry demonstration kitchen, each with an adjoining classroom enabling both theoretical and practical training to be given. Folding doors between the class rooms and intersecting corridor can be opened to enable them to be used as a single unit if required. The best use is made throughout of natural light by means of large windows and glass bricks. This efficient lighting, with the high standard ventilation and heating, ensures ideal working conditions under which staff can be trained in all branches of canteen catering.

As the general kitchen is fitted with the latest standard equipment of London Transport canteens, and a display room has been provided with specimens of all other types still in use, students will be able to familiarise themselves with all types of equipment likely to be met when they have passed out and are allocated to canteens. Courses at the centre vary in length from one to eight weeks and are run by a chief instructor and four assistant instructors, and lectures are included to give background knowledge of the traditions and organisation of London Transport, the function of the welfare department, the canteen system, conditions of service, wages, hygiene, first aid and fire precautions. Refresher courses are given for canteen staff recruited during the war and evening classes in domestic cookery are available for junior members of the staff.

International Organisation for Standardisation

MEETINGS of five of the technical committees of the International Organisation for Standardisation have recently been held in Paris. The committees in question are those concerned with Bolts, Nuts and Accessories; Limits and Fits; Screw Threads; Preferred Numbers, and Welding. British representation on the committees was arranged by the British Standards Institution. In what follows we give a brief summary of the proceedings of each of the committees.

Bolts, Nuts and Accessories.—The scope of work to be undertaken by the committee was discussed at considerable length and it was finally agreed that it should cover "bolts, nuts and metal thread screws, of the most commonly used types, and accessories (such as washers and split cotter pins)." Items such as rivets, boiler stays and all bolts and screws of limited use are regarded as outside the scope of the work. It was decided that the programme of work should be to prepare internationally agreed recommendations dealing with all important dimensions of the products coming within the scope of the committee, with their tolerances (with the exception of thread tolerances), and to prepare a system of symbols identifying in a non-ambiguous way all kinds, varieties and important characteristic features of the products, e.g., machining finishes and grades of accuracy. As a basis for discussion the secretariat had prepared proposals relating to a system of identification symbols, a general plan of dimensions for all of the common types of bolts, nuts and screws, and suggestions for definitions relating to the overall lengths of bolts and screws and to the length of thread. Since the proposals relating to general dimensions and identification symbols required considerable detailed study on the part of the participating nations, it was agreed that each country should, within the next three months, submit its suggestions and comments on the proposals. The secretariat would then prepare new proposals in the light of the comments submitted and circulate them to the participating countries for their further study. Detailed consideration was given to definitions for the overall lengths of bolts and screws and of the length of thread. The features in regard to which there were widely differing viewpoints were first, that of including or omitting the thread run-out as part of the length of thread, and the question as to whether the length of bolts, screws and studs should be the overall length or the length from the first full form thread. Appropriate committees of the British Standards Institution are to study the definitions which have been recommended.

Limits and Fits.—The document defining the scope of the committee's work was amended to include tolerances and symbols for "rough and finished parts," and the establishment of the principles which should govern the inspection of these parts. In this connection, the Swedish delegation pressed the question of establishing tolerances for products such as tubes, drawn steel sections, &c., which may be used in manufacture without further machining, and undertook to submit proposals to the secretariat. The main discussion of the committee was devoted to the question of the adoption of Bulletins 24 and 25 of the former International Standards Association as a basis for its work. I.S.A. Bulletin 24 specifying the standard temperature of measurement (20 deg. Cent. or 68 deg. Fah.) was adopted unanimously and without discussion. The British delegation proposed that the title of I.S.A. Bulletin 25 should make it clear that it referred to tolerances and fits in the metric system from 1mm to 500mm. This was agreed, and it was also decided that it should include a glossary of the various terms employed, in English, French and Russian. It was decided that Bulletin 25 should be adopted as a basis for the future work of the committee, and that studies should be made in various countries with a view to improving the data given in the bulletin and extending it to diameters below 1mm and above 500mm. It was also decided that those studies should include experiments to correlate the results of inspection by direct measurement and by gauging.

Screw Threads.—The secretariat of this committee is the responsibility of Sweden, which has sponsored a number of proposals for a basis for a single world system of screw threads. The British delegation recommended that it would be better to recognise the fact that for the foreseeable future there must be two systems, one for the metric and the other for the inch basis of measurement, but that a step forward might be made by agreeing on a standard profile for triangular threads in both these systems. This proposal was accepted. The unified screw thread system for sizes from ¼in and upwards was agreed upon for the inch basis, and the profile of the unified thread was accepted for metric screw threads having a pitch of 1mm and over. This resolution was not endorsed by the delegations from the U.S.S.R. and Italy, while the delegation from Czechoslovakia reserved its decision. It should be understood that an I.S.O. resolution represents an international recommendation to the various national standardising bodies, but does not in itself constitute a standard. The committee concluded its work by laying down a programme for standardising threads with triangular profiles both above and below 6mm diameter, and also threads with other than triangular profiles, and a small working commission, on which the United Kingdom will be represented, was appointed to assist the Swedish secretariat in the preparation of documents and data for this future work.

Preferred Numbers.—It was decided that this committee's task should be to specify what are preferred numbers in the abstract, and to put them into series of linear dimensions to be of use to other expert committees. It was also agreed that the co-ordination of Bulletins 11 and 19 of the former International Standards Association, and the various corresponding national standards, should be a particular part of the scope of the committee's work. After considering the tables of preferred numbers in I.S.A. Bulletin No. 11, and after a long discussion regarding the various ways of rounding off the numbers, the chairman asked each delegation whether it accepted the table in its present form. Only the Swiss delegation objected to doing so, but the U.S.S.R. delegation said that it would like to see some revision. Subsequently some modifications were agreed upon, in particular that the order of preference of the series R 5 to 40 should be indicated. The committee also devoted some attention to the co-ordination of the application of preferred numbers in various fields, and it was agreed to set up a sub-committee to establish a draft I.S.O. recommendation, based on I.S.A. Bulletin 19, and to complete the draft by proposals for the ranges of dimensions below 1mm and above 500mm.

Welding.—Some discussion took place on the relationship of the committee to the International Institute of Welding, and a formal resolution was adopted expressing the intention of the committee to refer to the I.I.W. specific technical questions on which existing national standards, or other documentation at its disposal, did not appear to be a sufficient technical basis of work. Welding definitions and symbols were then considered, and the view was expressed that a combination of the American and Swedish proposals might lead to a very satisfactory international system. A sub-committee was formed to examine and submit fresh data and suggestions, keeping in mind the objective of finding the best international solution for further consideration at a later conference. There was a lengthy and inconclusive discussion on the specification of weldability, but recommendations were made as to the chemical specification, and the desirability of early standardisation of mechanical tests of the base metals, for transmission to the appropriate committees dealing with those subjects. The committee agreed that a specification of weld quality should be a prior part of its future work. On the question of electrodes and filler rods, a resolution was adopted recommending the desirability of adopting a diameter series based on the existing I.S.A. series of preferred numbers, and a particular series was proposed for reference to the different countries for consideration. The following sub-committees were formed, on all of which the British delegation requested representation:—Symbols and Joint Nomenclature, Definitions of Weld Positions, Design Calculations, Electrodes and Filler Rods, Arc Welding Equipment, and Weld Quality.

American Engineering News

Engineering Staff Requirements

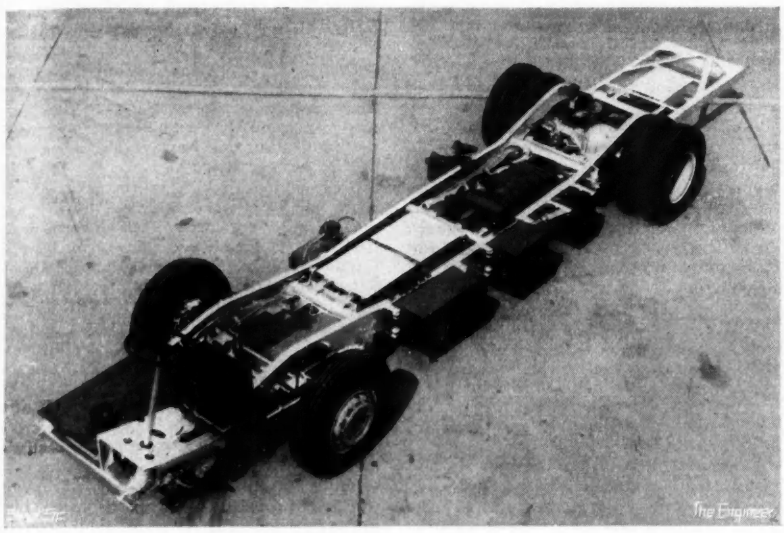
According to the *Engineering News-Record*, a recent report by the Engineers' Joint Councils General Survey Committee has revealed that the demand for graduate engineers is likely to be less this year than last. Returns obtained from 162 industrial concerns and thirty-one Government agencies show they are likely to require 21 per cent fewer graduates this year than in 1948, approximately 8175 as opposed to 10,400. Industrial companies show a 26 per cent decrease in the numbers required, whereas Government departments are likely to require only 9 per cent less. It is revealed that graduate engineers will receive an average commencing salary of 255 dollars per month, and while it is estimated that civil and electrical engineers will be in the greatest demand, these two groups will be the lowest paid. Of the 1950 civil and 1960 electrical engineers to whom posts will be offered, the average salary will be 250 dollars per month. The highest paid will be chemical and ceramic engineers, 290 dollars per month being the starting salary for those with bachelor degrees. Dealing with increments, it is shown that civil engineering graduates starting at 250 dollars can expect to make 270 dollars after the first year. Salaries among civil engineers with bachelor degrees and ten years' experience average 400 dollars per month. All other branches of engineering reveal higher averages than this; the mechanical-aeronautical-industrial group with ten years' experience is averaging 500 dollars per month. No doubt as a result of the intensive highway development now being carried out, the State governments are expected to provide an increased number of openings against 1948, it being anticipated that 1075 graduates will be required, which is an increase of 40 per cent over last year. In industry, transport and the motor-car manufacturing fields are likely to provide the greatest number of openings, whilst the lowest need will be among consulting engineers whose intake is likely to approximate 46 per cent less than in 1948.

Anti-Roll Device for Ships

A stabilising system claimed to reduce the roll of ships by as much as 80 per cent, is to be tested on a United States Navy minesweeper next month. It is termed the "activated tank" system and is of the well-known kind, in which two pairs of large tanks mounted on opposite sides of the ship are half-filled with water and are connected across the ship by ducts. Electronically-controlled pumps transfer the water backwards and forwards through the ducts at a rate calculated to counterbalance the ship's roll. The electronic equipment controlling the pumps is arranged so as to "detect" the roll at its beginning. The system has been the subject of experiments by the United States Navy since 1937, the tests being suspended during the period of hostilities and resumed again after the war. It is said to be more efficient, less expensive, and less bulky than other types of stabilisers.

Trolleybus with Side-Mounted Electrical Equipment

We learn that the first left-hand-controlled version of the B.U.T. transit-type trolleybus, model "ETB 1," was recently tested on the road prior to its shipment to Denmark for operation in Copenhagen. When this 33ft long, low-framed model was introduced by British United Traction, Ltd., twelve months ago for export only, the design had been specially arranged for either left- or right-hand driving controls and with the contactor gear and a main resistance disposed on the rear frame overhang—an unusual arrangement. So far the majority of orders received have been for right-hand-controlled machines, well over a hundred of these being for service in Australasia.



"ETB 1" Trolleybus Chassis with Side Mounted Equipment

Left-hand controls, however, were specified when Copenhagen ordered four "ETB 1" models with Metropolitan-Vickers electrical equipment, and the municipality also required a rearrangement of the equipment so that a strengthened rear end could be provided for towing trailer buses and for carrying a concentration of standing passengers on the rear platform.

Previously the general disposition of the main units on the "ETB 1" chassis has been: steering gear, controls and combined controller and reverser mounted on the lengthy front chassis overhang; the first main resistance, 130 h.p. main motor, motor-driven air compressor and reservoirs, and shunt field resistance, all mounted amidships, and the second main resistance and contactor gear both mounted on the downswept rear chassis overhang.

In the trolleybus for Copenhagen, as illustrated herewith, the contactor gear has been removed from the extreme rear end of the chassis, and is now housed in two metal-clad cases attached to the outside of the chassis frame member between the axles and just forward of the shunt field resistance. Two air reservoirs, one for the forward door and one for the brakes, lie longitudinally alongside the master controller on the front chassis overhang. An air reservoir for operating the rear door is strapped to the tubular cross member immediately behind the rear axle.

All reservoirs are fed from a motor-driven 10 cubic feet compressor which, together with a 1200-W motor generator for the batteries and vehicle lighting, is mounted amidships on the outside of the right-hand frame member. As a normal precaution, the brake and door reservoirs operate as separate systems.

With this rearrangement of units, the rear overhang on the Copenhagen vehicles now only carries the second main resistance, which is mounted well below frame height. The overhang is specially lengthened by 10in, giving an extension of 102in behind the rear axle, and is flitched to carry twenty-five standing passengers. Diagonal bracings and a robust cross member provide additional strength for towing a trailer bus loaded up to 10 tons, as is customary in the city.

The position of the driving controls on the left-hand side has been obtained with a minimum of structural alteration. The mechanical linkage for the hand brake to the rear wheels still runs down the right-hand side of the chassis and crosses over to the left-hand side by a simple cross shaft fitted directly in line with the hand brake ratchet mechanism.

In addition to the air pressure braking, the system incorporates a stabilised rheostatic electrical unit which ensures that vehicle transmission cannot be overloaded no matter what the vehicle speed is when brakes are applied.

Stiffer springing with reduced deflection is used to counterbalance the redistribution of weight and to accommodate the load of standing passengers on the rear platform. The effectiveness of this springing was one of the points under observation when the trolleybus was taken to the Atherton depot of South Lancashire Transport for its initial trial run. During the run the vehicle was loaded up to 11 tons 5 cwt, plus eleven standing passengers, making a total weight of some 12 tons. Its rolling characteristics were considered to be good, and the stiffer rear springs, together with the large-capacity "Luvax P 9" shock absorbers fitted to front and rear axles, gave smooth riding without the manifestation of any pitching.

The traction motor is a high-speed machine with a one-hour rating of 125 h.p. at 550V, and the unit is floodproof up to the centre line with air inlet and outlet at the top where dust and moisture are less likely to enter. During the road tests a series of readings taken on the last notch of the controller gave a balancing speed of 34·6 miles an hour, with a 10⅛ to 1 rear-axle ratio, after allowance for line voltage had been made. After a 33 miles run from Atherton depot via Swindon depot to Walkden and return, the thermometer temperatures of the motor were 55 deg. Cent. for the commutator, 71 deg. Cent. for the field, and 25 per cent. for ambient air.

The rearrangement of the electrical equipment from the rear to the frame side member is not peculiar to the Copenhagen buses; a similar lay-out is being incorporated on thirty-eight B.U.T. trolleybuses for Wellington. In this case, side-mounted equipment has been specified so that the bodywork over the rear chassis overhang can be arranged for a perambulator and a luggage compartment.

A Portable Air Compressor

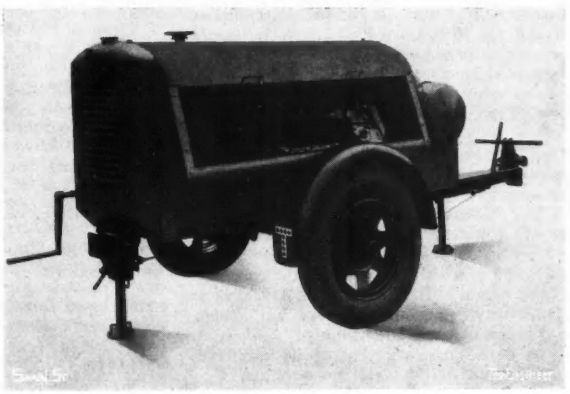
We reproduce below a photograph of a portable air compressor of new design which has been added to the range of plant manufactured by Ingersoll-Rand Company, Ltd., 165, Queen Victoria Street, London, E.C.4. The compressor is a two-stage, air-cooled radial unit with a capacity of 105 cubic feet of free air per minute at 100 lb per square inch.

In this unit an air-cooled intercooler removes the first stage heat of compression before the air passes to the high-pressure cylinder. To effect this cooling atmospheric air is drawn by a fan through the intercooler sections and dispersed over the finned cylinders of the compressor. Channel type inlet and discharge valves are fitted to the unit and on top of the inlet valves on all cylinders unloaders are mounted for starting purposes.

A new design of Petter four-cylinder engine drives the compressor unit through a Borg and Beck segmental clutch. The friction face of the clutch can be renewed without necessity for dismantling the engine or compressor. The engine is rated at 32 b.h.p., and as the compressor drive requires only 24·4 b.h.p. there is an ample reserve of power available.

The engine can be started by hand through a decompressor device which is automatically tripped out of engagement after the required number of revolutions have been made and the fly-wheel carries sufficient energy to turn the engine over compression. Electric starting equipment operated from a 12-V battery is also available. In this equipment the dynamo is vee-belt driven from the forward or gear end of the engine, and a suitable motor flange mounted on the bell housing operates a toothed ring shrunk on the fly-wheel.

The assembly is of unit construction, a bell housing which encloses the clutch forming a direct connection between the compressor and engine crankcases. The complete unit is mounted on a deep constructional steel framework which carries the engine radiator on one end and the intercooler, fuel tank and air receiver on the other end. The assembly is mounted on a highway trailer having a heavily sprung axle and two heavy-duty pneumatic-tyred wheels. This mounting is designed for towing at speeds up to 20 miles an hour and is fitted with parking and overrun brakes. The unit is fitted with roller shutters which can be locked in the closed position.



Portable Two-Stage Compressor

Industrial and Labour Notes

The Trades Union Congress

During the past week there has been issued some preliminary information about the resolutions which are to be submitted to the Trades Union Congress at Bridlington in September. A resolution to be put forward by the T.U.C. General Council calls for endorsement of its economic policy which, the Council claims, is designed "to restrain a general increase of personal incomes and expenditure unrelated to higher productivity." This policy, the General Council says, indicates the only way by which Britain can maintain full employment, safeguard its social security programme, improve its standards of life, develop its nationalised industries, and establish British trade and industry on a basis enabling the country to play its part in the development of a world-wide system of multilateral trade with freely convertible currencies. Resolutions from affiliated unions, the T.U.C. adds, show that there is a large measure of support for this policy. At the same time, some of the affiliated unions' resolutions call for price reductions, less taxation in the lower income groups, extension of cost-of-living subsidies, and a reduction in profits.

Another group of resolutions to be put before the Congress deals with questions of policy and organisation in the nationalised industries. These resolutions, the T.U.C. states, reflect the desire of various unions for the extension of public ownership to industries in which their members are employed, and press for consideration of problems which experience in running nationalised industry has emphasised. Among the unions calling for extension of nationalisation are the United Rubber Workers of Great Britain for the rubber manufacturing industry, and the Amalgamated Union of Foundry Workers for the main sections of the engineering and foundry industries. The Transport and General Workers' Union has tabled a resolution which expresses concern over the present composition of the boards of nationalised industries, and which urges that extensive training schemes should be provided to enable workers to fit themselves for the duties and responsibilities of management. "The necessity for efficiency and the fostering of a new industrial outlook," the T.U.C. observes, "are stressed by more than one union, and firm indications are given that trade unions feel that they can make a special contribution to solving the difficulties which both public and private enterprises are facing to-day."

On the subject of organisation in the nationalised industries, one proposal—made by the National Union of Public Employees—is for the formation of a new joint committee of members of the T.U.C. General Council and representatives drawn from the appropriate unions, together with specialists appointed by the T.U.C. The task of such a committee, it is suggested, would be to educate workers in the responsibilities which nationalisation has imposed and "in the benefits which it has brought to them." In addition, the Association of Supervisory Staffs, Executives and Technicians is urging the creation of a definite scheme for the education of trade unionists in the techniques of industrial management.

Railway Wages

The Conciliation Board appointed, under the chairmanship of Sir John Forster, to examine the question of railwaymen's wages, began its sittings in the early part of this week. It is understood, however, that no statement as to its proceedings is likely to be made until the discussions have been concluded. The principal matter for consideration by this Board is the claim made by the National Union of Railwaymen for a general wage increase of 10s. a week, and additional payment for Saturday afternoon work. In its present deliberations the Board is not concerned with railway shopmen's wages. A separate Board—consisting of the same members as the board now sitting—has been set up to deal with that matter.

A meeting called by the London district council of the N.U.R. was held on Monday last. At it a resolution was put forward calling for "work-to-rule" action to enforce the wage claim, but after discussion it was rejected by a small majority. It is reported, however, that should the Conciliation Board not have reached a decision by August 22nd a meeting of N.U.R. branch chairmen in the London area is to be held to consider future action.

Iron and Steel Production

Production statistics issued this week by the British Iron and Steel Federation show that, despite the incidence of annual holidays, the output of steel ingots and castings averaged 244,100 tons a week in July. This represents an annual production rate of 12,695,000 tons, compared with 12,084,000 tons in July, 1948. Commenting on steel output in the first seven months of this year, the Federation says that last year's record production has been exceeded by 431,000 tons. The output of pig iron in July averaged 177,400 tons a week, so that production was running at an annual rate of 9,224,000 tons. In July, 1948, the annual rate was 8,908,000 tons.

Britain's Exports and Imports

In the latest issue of the *Board of Trade Journal* a survey has been made of the volume of United Kingdom exports and imports in the second quarter of 1949. It explains that from the beginning of 1947 the value of British exports rose in each quarter until the second quarter of 1949, when, at £431,900,000, it was £28,000,000 lower than in the preceding three-months' period and £1,300,000 below the value in the last quarter of 1948. The volume of exports in the second quarter of this year is estimated at 146 per cent of the 1938 average, compared with 156 per cent in the first quarter and 147 per cent in the last quarter of 1948. The volume of exports for the first six months of this year was therefore 151 per cent of 1938, compared with the forecast of 150 per cent made in the "Economic Survey for 1949." The export target for end-1949 is 155 per cent of the 1938 average.

The survey shows that, during the second quarter, exports of manufactured goods were, in volume, 168 per cent of the 1938 average, but were 6 per cent lower than in the first quarter of this year. Exports of metal goods declined during the second quarter from 236 per cent to 224 per cent of 1938. This group includes machinery exports which fell to just over twice the average of 1938 and to 5 per cent below the 1949 target rate. Exports of vehicles, although 4 per cent lower than in the preceding quarter, were still three times the average of their pre-war volume, and exceeded their target figure by 3 per cent. Coal exports in the second quarter were just about the same as in the preceding quarter and did not amount to much more than half the target. Exports of other raw materials fell from the 68 per cent of the 1938 average achieved in the first quarter of this year to 52 per cent in the second quarter.

The value of total imports for the second quarter of 1949 was £581,600,000, the highest quarterly total ever recorded, and £43,400,000 above the figure for the first quarter. There was a slight increase in the second quarter in the value of re-exports, but the value of retained imports was the record figure of £566,100,000. By volume, retained imports in the second quarter were 88 per cent of the 1938 average, compared with 82 per cent in the first quarter. The volume of retained imports for the first half-year was, therefore, 85 per cent of the 1938 average, or two points above the "Economic Survey" forecast. As to the terms of trade, the *Board of Trade Journal* says that, while export prices remained unchanged between the two quarters, import prices in the second quarter of 1949 were, on an average, 1 per cent lower. A slight improvement in the terms of trade was therefore to be detected, although the deterioration, compared with 1938, is still of the order of 20 per cent.

Industrial Trends

The British Institute of Management has recently published the text of an address on "Management in Private Enterprise and Nationalised Industry," which was delivered by Sir Miles Thomas at the fifty-third Oxford Management Conference, held in May. Commenting, in the course of that address, on some industrial trends, Sir Miles said that he found the pressure of competition to be steadily increasing, and that we had now emerged from the immediate post-war period when "there was an extraordinary lack of good clean, hard-hitting competition." In the sellers' market there had been a carry-over from the war of quantitative standards of production without the cost factor being paramount, and the problems of management had been concerned with getting things done rather than with the cost of getting them done. But, Sir Miles asserted, both internally between individual firms and also internationally the business of selling was beginning to become active again.

Most skilled operatives nowadays, Sir Miles continued, had lots of time to think, and they were beginning to understand, with a very considerable degree of penetration, the economic problems of production. The workers knew to-day that there was a falling off in orders, whether through soft salesmanship or through increasing economic pressure, and they knew that that was going to have an effect on the need for their personal services. It might mean short time, or it might mean temporary redundancy or change of employment. Therefore, Sir Miles considered, the workers had a justified curiosity about the way in which the industry in which they were engaged was being run. Through joint production councils the worker could bring pressure of inquiry to bear on the management, and the management on its part had an obligation to take the worker into consultation to an effective and realistic extent. In his experience, Sir Miles said, joint consultation was fundamentally no more than the full development in an industrial democracy of the principles of sound leadership.

O.E.E.C. Report on Iron and Steel

The Organisation for European Economic Co-operation has now published a report (H.M. Stationery Office, price 1s.) dealing with problems related to the increase and co-ordination of iron and steel production in the participating countries. The report estimates that the 1952–53 production of crude steel in the O.E.E.C. countries will total about 57,500,000 tons, an increase of 58 per cent over the 1935–38 figures, if German production is excluded. Including Western German steel production—which is limited by international agreement—the total increase will be 30 per cent over 1935–38. Ultimately, when existing development plans are completed, steel output is expected to reach somewhere about 59,000,000 tons.

The report indicates that, except for small quantities of special steels, no imports of steel will be required from the U.S.A. by 1952–53, and the dollar cost will thus fall to 42,000,000 dollars, compared with a planned figure of 166,000,000 dollars for 1948–1949. It is explained that several O.E.E.C. countries are aiming at a greater degree of self-sufficiency in steel production, and that, consequently, traditional exporters will need to find new outlets for their products. But the marketing position is likely to be complicated by the fact that many countries formerly importing steel from Europe are also expanding their own steel-making capacity. It is estimated that, by 1952–53, the demand outside O.E.E.C. countries will not exceed 4,000,000 tons.

French Engineering News

(From our French Correspondent)

The new battery of forty-two coking ovens is expected to be installed at the Aciéries de Micheville by the end of 1949. The company has also contracted with the Société d'Equipement Thermique de la Sidérurgie for the construction of a 25,000-kW turbo-generator. Increased cast iron production has resulted from the lighting of a fourth blast-furnace at the Longwy steel plant's Mont-Saint-Martin works. A third blast-furnace has been started at the Thionville plant, where two units are producing Thomas steel and one pure iron. The programme undertaken by the Union Sidérurgique du Nord de la France (Usinor) includes the electrification of the blooming mill at Louvroil, a new 75-ton Martin oven at Denain and a tunnel oven for refractory products. In addition, equipment for forging wheels and hooping will be installed at Valenciennes and improvements made to existing installations.

* * *

Monsieur Robert Lacoste, French Minister of Industry and Commerce, stated in a speech at the Sarlat power station, now under construction, that France will be subjected to electricity cuts until 1952. Nevertheless, production will rise to at least 40 milliard kWh a year by 1952, against 30 milliard kWh in 1948. By 1952, the Minister said, electricity production would be sufficient to cover normal needs even during severe droughts. New mining plants are to be constructed and will themselves provide 450,000kW.

The Organisation for European Equipment and Construction has published a report on electricity power problems, in which it states that, despite national programmes, the nineteen member countries will still have an electricity deficit of about 16,600 million kWh in 1952. The solution suggested by the report consists of the construction of a number of "international plants," whose production would go to supply European countries. These plants would have a total capacity of 7·8 million kW and production amounting to 28·2 milliard kWh, or the equivalent of French production in 1948. They would cost 1949 million dollars. Even then, although covering the deficit, consumption would still have to be restricted in order not to impede industrial production.

* * *

Coal production for the first half of 1949 was the highest obtained since the record year 1930, and amounted to 26,900,000 tons, or 1,050,000 tons more than the first six months of 1948. The relative reduction shown since April is due simply to paid holidays and consequent reduction in man-hours. Coal-face output has continued to improve through the half-year, the weekly average being 1084kg, or 12 per cent more than the corresponding period last year. Absenteeism has also dropped from 16·80 per cent in the first half of 1948 to 14·25 per cent in the first half of 1949. Since the 12 per cent manpower decrease in 1948, the variation has been less marked, but the tendency to decrease continues, which may present a danger for future production.

Reserves of coal in the Djerada, Algeria, mine are estimated at over 1 milliard tons. This estimate follows additional study after the initial programme had established the existence of 100 million tons. Coal produced by Djerada is very good quality anthracite. Production in 1947 amounted to 268,000 tons, rising to 290,100 tons in 1948, and 1949 production is expected to be 400,000 tons. The mines also supply briquettes to the Moroccan railways. Output of commercial fuel improves steadily, passing from 450kg in February, 1949, to 560kg in June, 1949, whereas the average for 1948 was only 393kg. The present output is carried from the Djerada mines to the Guenfouda preparation plant by a 23-km telpher. A railway, which will enable maximum output of the mine to be transported, has been under construction since July, 1948. It will be 45km long and will be completed in 1950. A new 280 tons-an-hour washing plant is to be installed in the mine and will improve the quality of the products.

Notes and Memoranda

Rail and Road

BRITISH TRANSPORT TRAFFIC RECEIPTS.—The latest returns made by the British Transport Commission show that, in the four weeks ended July 17th, traffic receipts of British Railways totalled £27,352,000, an increase of £94,000 on the receipts in the comparable period of 1948. For the first twenty-eight weeks of this year, however, the total traffic receipts of British Railways were, at £172,109,000, more than £3,000,000 below those of the corresponding period last year. London Transport traffic receipts in the four weeks ended July 17th amounted to £4,414,000, compared with £4,383,000 in the corresponding period of 1948.

LOCOMOTIVE WATERING DIFFICULTIES IN THE WEST HIGHLANDS.—The Scottish Region of British Railways says that owing to the prolonged spell of dry weather in the West Highlands the burgh authorities of Fort William have had to restrict the water supplies to the motive power depot in the town because of the shortage of water in the district. The water supply to the depot has been cut off each day for certain periods, and the position has been made more acute by the fact that the water columns at intermediate points on the West Highland Line in many cases have ceased to supply water. Typical examples are the columns at Tulloch and Glenfinnan, where water supplies in the past have never been known to fail. In order to meet the situation and to keep going at Fort William, British Railways transferred a 500 gallons per minute trailer pump from Glasgow, which is now being used to pump water from the River Ness to the supply tank at the motive power depot. With the assistance of the local fire brigade, which has lent a number of lengths of fire hose, the intervening 834 yards between the river and the supply tank have been spanned. The motive power depot at Fort William is situated alongside Loch Linnhe, but as this is a sea loch the water is entirely unsuited for locomotive purposes. Normally twenty-two engines are "watered" each day at Fort William, the consumption being in the region of 66,000 gallons.

Air and Water

BRITISH AIRWAY'S TRAFFIC STATISTICS.—The Ministry of Civil Aviation has now issued traffic statistics of the British Airways Corporations for the month of April. During that month the Corporation's aircraft flew 48,000,000 passenger miles, an increase of 15 per cent on the preceding month and 12 per cent more than in April, 1948. Nearly 6,750,000 load ton-miles were flown by the three Corporations in April, an increase of 11 per cent compared with April, 1948. The aircraft mileage flown by the Corporations was 3,500,000. This, the Ministry says, was about the same as in April last year, but the capacity made available this year was 20 per cent greater.

NORTH WALES HYDRO-ELECTRIC SCHEMES.—The British Electricity Authority states that it has withdrawn its application to the Minister of Fuel and Power for an authorisation under Regulation 56A of the Defence (General) Regulations, 1949, in respect of the suggested extension of the catchment area of the Dolgarrog hydro-electric scheme in North Wales. While fully concerned to secure the preservation of other amenities as well as the provision of electricity, the Authority has decided that, in view of the objections lodged against the Dolgarrog proposal, of which it had given public notice, and of the objections of a somewhat similar nature which have appeared in the local and national Press to the other hydro-electric schemes now being investigated, it will not proceed with the Dolgarrog project as a separate matter. All the proposed schemes for hydro-electric development in North Wales will be dealt with collectively by Parliamentary procedure. By this procedure the Authority desires to ensure the fullest opportunity for detailed examination of its proposals, together with consideration of any objections which may be raised to them.

Miscellanea

EXCAVATOR CONTROL ENDS.—The Ministry of Supply states that the allocation scheme for Government surplus crawler excavators has now been discontinued. In future, such machines will be sold free of restrictions on resale in the United Kingdom. All the wartime controls on the distribution of excavators in the United Kngdom are now ended. Surplus excavators can be obtained from the Director of Disposals (R.E.9), Ministry of Supply, Great Westminster House, S.W.1.

INSTITUTION OF RADIO ENGINEERS.—The British Institution of Radio Engineers announces the award of its Marconi Premium to Mr. F. C. F. Phillips, of the General Electric Company, Ltd., Coventry, for his paper on "A Direct Reading Frequency Measuring Set." The award was made for the most outstanding engineering paper published in the Institution's *Journal* during 1948.

THE LATE MR. PRESTON MILLAR.—We have learned with regret of the death in New York on June 17th of Mr. Preston Strong Millar, president of the Electrical Testing Laboratories, Inc. Mr. Millar was born in 1880, and devoted the whole of his working life to testing laboratory work and illuminating engineering. He was one of the founders of the American Illuminating Engineering Society, and was a member of the British Illuminating Engineering Society. He took an active part in the work of the International Commission on Illumination.

ARMOURERS AND BRASIERS' RESEARCH FELLOWSHIP IN METALLURGY.—A joint committee of the Royal Society and the Armourers and Brasiers' Company has appointed Robert William Kerr Honeycombe, M.Sc., of the Cavendish Laboratory, Cambridge, to the Armourers and Brasiers' Research Fellowship for two years from October 1, 1949. The appointment is renewable year by year for a further three years. Mr. Honeycombe will work on the inhomogeneity of plastic deformation in metals and the influence of these inhomogeneities on recrystallisation and recovery.

ASLIB ANNUAL CONFERENCE.—Aslib's annual conference is to be held, under the presidency of Dr. Percy Dunsheath, from Friday to Monday, September 9th to 12th, at Ashorne Hill, near Leamington Spa. The subjects selected for discussion at five sessions of the conference on Saturday and Sunday are: "Business Archives," "Some Recently Started Special Libraries," "Correspondence as a Source of Economic and Technical Information," "Official Publications," and "The Library as a Tool of the Theatre." The head office of Aslib, from which full particulars of the conference can be obtained, is at 52, Bloomsbury Street, London, W.C.1.

BRIGHTER FACTORIES.—Work on the application of colour to the interiors of factories, offices and industrial establishments generally has now passed the experimental stages, and it is generally agreed that the intelligent use of colour can do a great deal to eliminate the somewhat drab appearance of buildings and machines. Colour correctly applied does undoubtedly establish a cheerful working environment and, when coupled with correct lignting, greatly minimises eyestrain. With all these matters in mind, Pilchers, Ltd., has recently produced a useful pamphlet setting out the basic principles governing the choice of colours and their practical application to workshops, machinery, offices and canteens.

INSTITUTION OF WORKS MANAGERS.—The second national conference of the Institution of Works Managers is to be held at the Prince of Wales Hotel, Harrogate, from Friday to Sunday, October 7th to 9th, under the chairmanship of Mr. A. P. Young. The general theme of the conference discussions is: "Producing Better Goods at Lower Cost," and Mr. W. C. Puckey will give an opening talk on the subject on Saturday morning, October 8th. Papers to be presented include "The Contribution of Simplification and Standardisation," by Mr. E. Woodbridge, of the British Standards Institution; "The Contribution of Time and Motion Study," by Mr. J. W. Hendry, and "The Contribution of Research," by Dr. B. J. A. Bard, of the Federation of British Industries.

BRITISH INDUSTRIES FAIR, 1950.—It is reported by the organisers of the British Industries Fair that applications have been received for more than half of the total space available at Earls Court and Olympia in London. In Birmingham, where a similar proportion has been received by the Chamber of Commerce, extensions are being made to the outdoor section. The Fair will be held at both centres from May 8 to 19, 1950. In the London section over 800 exhibitors have applied for more than 300,000 square feet out of a maximum of 555,000 available, and the organisers are now assessing the scale on which each industry will be represented. At Birmingham there is no fixed closing date for application for space, and the rate is so far well up to last year. By conversion of 40,000 square feet of car park the available stand space will be increased to 450,000 square feet, making possible a special display of British contractors' plant. It is stated that the three post-war Fairs have attracted a total of 48,000 overseas trade buyers.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

British Society for International Bibliography

Fri., Aug. 19th.—British Standards Institution, 28, Victoria Street, S.W.1, extraordinary general meeting, 2.15 p.m.

Engineering and Marine Exhibition

Thurs., Aug. 25th, to Sat., Sept. 10th.—Olympia, London.

Institute of Road Transport Engineers

Thurs., Aug. 18th.—NORTH-WEST CENTRE: Visit to the works of Leyland Motors, Ltd., Leyland, Lancs, 10.30 a.m.

Institute of the Motor Industry

Sat., Aug. 27th, to Sat., Sept. 10th.—St. Catherine's College, Cambridge, third annual summer school.

Institution of Naval Architects

Tues., Aug. 30th, to Fri., Sept. 2nd.—Autumn meeting, Copenhagen.

Personal and Business

LIEUT.-COLONEL I. A. Marriott has been appointed a director of Parsons Engineering Company, Ltd.

DR. A. J. KESTERTON, M.Eng., F.I.M., has been appointed melting shop manager at the new Abbey Works of the Steel Company of Wales, Ltd.

DUNLOP, Ltd., states that Mr. B. J. Wardle has been appointed S.E. England representative of its special products compositions division.

BASTIAN AND ALLEN, Ltd., announces that its head office and works are now at Ferndale Terrace, Harrow, Middlesex (telephone, Underhill 0440).

THE BRITISH WELDING RESEARCH ASSOCIATION, 29, Park Crescent, London, W.1, states that its telephone number is changed to Langham 7485.

JOHN A. SPARKS AND CO., Streatham Hill, London, S.W.2, have been appointed concessionaires in Southern England for W. H. Dorman and Co., Ltd., Stafford for spare parts and service facilities for Dorman oil engines.

S. WOLF AND CO., Ltd., Pioneer Works, Hanger Lane, London, W.5, informs us that as from August 1, 1949, the title of the firm has been changed to Wolf Electric Tools, Ltd.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., states that its Cambridge depot has moved to Fellowship House, 133, Fitzroy Street, Cambridge (telephone, Cambridge 54370).

MR. SYDNEY BARLOW, M.I. Struct. E., has been appointed manager of the bridge and constructional works of Dorman, Long and Co., Ltd., in succession to the late Mr. Pullan Mitchell.

MR. L. R. CHAMBERS has been appointed secretary to the National Council of Building Material Producers, 2, Caxton Street, London, S.W.1, in succession to Mr. M. G. Ionides.

MR. J. CHAPMAN and Mr. T. J. Andrew have been elected to the board of management of the British Colour Council. Mr. J. R. G. Marchetti has been re-elected chairman of the board.

THE GENERAL ELECTRIC COMPANY, Ltd., announces the retirement of Mr. J. A. Lacey from his position of works manager of the engineering department of the Witton works, after nearly forty-six years' service with the company. He is succeeded by Mr. E. Yeeles.

THE CONSOLIDATED PNEUMATIC TOOL COMPANY, Ltd., announces that it is opening a new factory in Johannesburg, and that Mr. John Barclay has been appointed works manager. The company expects that production in the new factory will begin before the end of the year.

MR. H. D. CHALLEN, A.M.I. Mech. E., has been appointed chairman, and Mr. A. E. Whyman, vice-chairman, of the British Power Press Manufacturers' Association. Mr. Gilbert T. Beach is the Secretary of the Association, the offices of which are at Standbrook House, Old Bond Street, London, W.1.

MR. J. MCNEAL has been appointed foreign sales manager of the Landis Machine Company, Waynesboro, U.S.A. For nearly thirty years Mr. McNeal has been attached to Alfred Herbert, Ltd., Coventry, as a specialist in Landis threading equipment and as European sales manager of the Landis Company.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd. states that the address of its Stoke-on-Trent office has been changed to Stoke Road, Stoke-on-Trent (telephone, Stoke 48630 and 48639). The erection and traction erection departments of the company's Birmingham office have been moved to 26–28, Holloway Head, Birmingham (telephone, Midland 3842).

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1.

TELEGRAPH MATERIAL (INSULATORS, POLE FITTINGS, &c.)

No. 16 : 1949. The previous edition, published in 1937, was, in its turn, a revision of part of the Interim Report, published in 1905 and entitled "British Standard Specifications and Tables for Telegraph Material." B.S. 16 specifies dimensions and mechanical tests for galvanised bolts and nuts, arm bolts, stay-swivels, stay rods and tighteners, tie bolts, arm combiners, brackets, insulators and spindles. The materials to be used are stated and electrical tests for insulators are prescribed. In the revised edition the designs of insulator permitted as a war emergency measure have been adopted as standard, and bolts and nuts to B.S. 916, "War Emergency British Standard for Black Bolts and Nuts," are adopted in place of those to B.S. 28. Other minor alterations have been made, including corrections to the tables of dimensions for insulator spindle gauges and insulator gauges. Price 7s. 6d.

CAST IRON SECTIONAL TANKS (RECTANGULAR)

No. 1563 : 1949. This standard deals with Cast Iron Sectional Rectangular Tanks which provide a convenient means for the bulk storage of a variety of liquids. As with all sectional assemblies the components are readily transportable and—subject to unit multiples—can be erected to give varying proportions of length to breadth and depth. The sectional tanks included in the standard are made up from 2ft, 3ft or 4ft square unit plates bolted together, giving depths of 2ft, 4ft, 6ft, 8ft, 10ft and 12ft with capacities from 280 to 75,000 gallons. The tanks are with external or internal flanges. Dimensions and thicknesses of unit plates and flanges stayings by means of tie rods and turnbuckles and struts and cast on connections are specified.

There are eleven tables dealing with scantlings, capacities and weights, drawings of tie rod ends and turnbuckles and four illustrations of typical tanks. Price 5s. post free.

PRESSED STEEL SECTIONAL TANKS (RECTANGULAR)

No. 1564 : 1949. This new standard deals with pressed steel rectangular sectional tanks which provide a convenient means for the bulk storage of a variety of liquids. As with all sectional assemblies the components are readily transportable and—subject to unit multiples—can be erected to give varying proportions of length to breadth and depth.

The sectional tanks included in the standard are made up from 4ft square unit plates bolted together, giving depths of 4ft, 8ft, 12ft and 16ft with capacities from 400 to 270,400 gallons. The tanks are with all external or all internal flanges or with internal bottom and external side and end flanges. Thickness of plates, permissible stresses, staying and connections are specified. Price 3s. post free.

SHIPS' CARGO LIFTING BLOCKS AND TYPICAL DERRICK RIGS

No. 408 : 1949. This revised standard has been extended by the inclusion of new provisions and appendices. The blocks specified are for use with wire rope and permissible working stresses on the components of the blocks are dealt with fully. Other clauses deal with materials, head fittings, sheaves and sheave diameters, strength of beckets, and proof load on beckets.

It includes a table of coefficients for estimating rope tensions making the necessary allowance for friction; nomenclature of head fittings as well as of derrick tackle when rigged should be found of considerable service; extracts giving the breaking loads of B.S. shipping and crane ropes; and extracts giving the core diameter and core area of B.S. screw threads for the screwed shanks of head fittings are included.

The graphic load diagrams for four typical rigged derricks with the loads on the parts of the rope computed from the table of frictional coefficients will be found of interest and value; and an appendix deals with the care and maintenance of the blocks in service. Price 5s. post free.

THE LATE MR. A. J. VENABLES.—We have learned with regret of the death of Mr. Arthur J. Venables, which occurred at Sheffield on July 30th. Mr. Venables was chairman and managing director of Hack Saws, Ltd., which firm he founded thirty-seven years ago.

Catalogues

BIRLEC, Ltd., Tyburn Road, Erdington, Birmingham, 24.—Publication entitled "Dry Gas."

HIGH DUTY ALLOYS, Ltd., Slough, Bucks.—Brochure describing and illustrating the parent factory.

DAVID BROWN TOOL COMPANY, Park Works, Huddersfield.—Publication entitled "Precision Hobs."

C.A.V., Ltd., Acton, London, W.3.—Brochure describing a photo-electric pressure and movement gauge.

J. H. FENNER AND CO., Ltd., Hull.—Catalogue number 130/7, dealing with fractional horsepower vee-belt drive.

B.X. PLASTICS, Ltd., Higham Station Avenue, London, E.4.—Publication describing some industrial uses of P.V.C.

AMES CROSTA MILLS AND CO., Ltd., Moss Ironworks, Heywood, Lancs.—Booklet describing the "Pneu" Pump.

DAVID BROWN AND SONS (HUDDERSFIELD), Ltd., Huddersfield.—Book describing automobile transmissions.

MUREX WELDING PROCESSES, Ltd., Waltham Cross, Herts.—Catalogue M 41, dealing with Murex welding accessories.

BRITISH JEFFREY-DIAMOND, Ltd., Wakefield, Yorks.—Catalogue number 1469, dealing with the "Atomill" fine grinder.

GEO. W. KING, Ltd., Hitchin, Herts.—Booklet "Lifting and Shifting," containing details of electric chain pulley blocks.

SKEFKO BALL BEARING COMPANY, Ltd., Luton.—Illustrated brochure entitled "SKF Bearings in Railway Rolling Stock."

NEGRETTI AND ZAMBRA, Ltd., 122, Regent Street, London, W.1.—Catalogue No. T/40, "Mercury in Steel Thermometers."

STANDARD TELEPHONES AND CABLES, Ltd., Connaught House, Aldwych, London, W.C.2.—Booklet of Standard fire alarm systems.

ELLIOTT BROTHERS (LONDON), Ltd., Century Works, Lewisham, S.E.13.—Leaflet describing the Elliott direct-reading humidity meter.

VENNER TIME SWITCHES, Ltd., Kingston By-Pass Road, New Malden, Surrey.—Leaflets covering a range of Venner time switches.

SPERRY GYROSCOPE COMPANY, Ltd., Great West Road, Brentford, Middlesex.—Brochure dealing with the Sperry Minor gyro compass.

SENTINEL (SHREWSBURY), Ltd., Shrewsbury.—Illustrated folder dealing with four and six-cylinder diesel engines (horizontal and vertical).

HENRY RIGHTON AND CO., Ltd., 97, St. John Street, London, E.C.1.—Booklet giving details of stocks held, together with some useful tables.

TAYLOR ELECTRICAL INSTRUMENTS, Ltd., Montrose Avenue, Slough, Bucks.—Catalogue and price list of electrical measuring instruments.

PLESSEY COMPANY, Ltd., Ilford, Essex.—Brochure describing a range of motor start capacitors, and catalogue dealing with electrolytic capacitors.

KEITH BLACKMAN, Ltd., Mill Mead Road, Tottenham, London, N.17.—Illustrated catalogue of fan engineering equipment and industrial gas systems.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., 21, Bloomsbury Street, London, W.C.1.—Publication number 257, dealing with joint box compounds.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., St. Paul's Corner, 1–3, St. Paul's Churchyard, London, E.C.4.—Illustrated catalogue of Metrovick fluorescent fittings.

CHURCHILL MACHINE TOOL COMPANY, Ltd., Broadheath, near Manchester.—French edition of precision grinding machine catalogue, describing applications to railway work.

Contracts

W. G. BAGNALL, Ltd., Stafford, has received an order from Imperial Chemical Industries, Ltd., for a locomotive for use by the Magadi Soda Company at its natural soda lake in Kenya Colony. The locomotive, which will be oil fired, is an 0–4–0 saddle-tank type with 12in by 18in cylinders. It is to be for metre gauge, but capable of ready conversion at a later date to 3ft 6in gauge.

THE BRITISH ELECTRICITY AUTHORITY announces that during the past month contracts have been placed for generation station, switching and transforming station and transmission equipment amounting in the aggregate to £2,877,386 3s. 7d. The principal contracts include: structural steelwork, Woolwich generating station, to Redpath, Brown and Co., Ltd.; two 240,000 lb/hr boilers, Acton Lane (Willesden) generating station and coal-handling plant, Thornhill generating station, to Mitchell Engineering, Ltd.; circulating water ducts and coal store drainage, Accrington generating station, to J. Jarvis and Sons, Ltd.; reconstruction of coal sidings, Leicester generating station, to Holloway Brothers (London), Ltd.; switchgear and miscellaneous electrical equipment, Brighton B generating station, to Metropolitan-Vickers Electrical Company, Ltd.; foundations, Carrington generating station, to A. Monk and Co., Ltd., and superstructure of main and ancillary buildings, Westwood (Wigan) generating station, to Wm. Moss and Sons, Ltd.

A Seven-Day Journal

The Rational Allocation of Coal

It is announced by the Combustion Engineering Association that a conference on "The Rational Allocation of Coal" will be held at the Palace Hotel, Buxton, on Thursday, September 8th, and Friday, September 9th. The conference will open on Thursday at 10 a.m., when a civic welcome will be accorded by the Mayor of Buxton. The chair will be taken by Mr. E. W. Thompson, the President of the Association, and a discussion on "The Training of Combustion Engineers" will take place. At the second session, at 2.30 p.m., the chairman will be Mr. P. A. Sanders, and the subject will be "The Technical Advisory Services." In his address the chairman will summarise the present state of the technical advisory services in connection with combustion engineering equipment, and the economic limit of such services. Papers will be presented dealing with after-sales services and operational services for industrial coal users and the services of mechanical and underfeed stoker makers and the makers of temperature control apparatus. On Thursday evening the conference dinner will be held. On Friday, September 8th, the whole day, at 10.30 a.m. and 2.30 p.m., will be devoted to the subject of "The Rational Allocation of Coal," the chairman being Mr. Lionel G. Locket. Eleven papers will be presented dealing with the points of view of water-tube boiler users, the electricity supply industry, the users of shell boilers and the choice of fuel for mechanical stokers for shell boilers, underfeed stokers and chain-grate stokers, and contributions from the users of vertical boilers, from the paper-making industry and other branches of industry are expected. The object of these sessions will be to show that the greatest contribution to fuel economy in the United Kingdom would be the development of a system of coal allocation based on consumer demand. Membership of the conference is open to all who may be interested, and applications should be made to the Combustion Engineering Association, 24, Tottenham Court Road, London, W.1.

Conversion of Locomotives to Oil Firing

In its third report, which was published by H.M. Stationery Office at the end of last week, the Committee of Public Accounts has commented on the expenditure on the scheme for converting British railway locomotives from coal to oil firing. The total expenditure on the scheme—which was abandoned in May, 1948—is estimated to have been nearly £3,000,000. The report recalls that the scheme was initiated by the Ministry of Transport, on the advice of the Ministry of Fuel and Power, in the summer of 1946, when it was expected that coal supplies would be short and oil plentiful for a number of years. The intention was to substitute 840,000 tons of oil a year for 1,000,000 tons of coal by converting about 1200 locomotives and providing ancillary equipment and storage depots. By September, 1947, the Ministry of Fuel had become doubtful as to whether the necessary oil could be obtained, and later the British Transport Commission informed the Ministry of Transport that it was not in favour of proceeding further with the project, as the extra operating cost would be over £3,500,000 a year. By the time it was finally abandoned in May last year ninety-three locomotives had been converted and a number of storage depots had been nearly completed. The report goes on to say that the Ministry of Transport's explanation was that, had the coal shortage materialised on the scale which it had been thought prudent to envisage, and had the conversion programme not been carried out, there would have been serious dislocation of rail traffic. The expenditure, the Ministry considered, was in the nature of insurance against a contingency which did not, in fact, arise. In its observations, the Committee of Public Accounts says that the dislocation would have been no less serious if 1200 locomotives had been out of action because there was no oil for them and they could not operate on the coal available. It recognises, however, the necessity sometimes to incur expenditure in order to meet expected contingencies. But the Committee points out that extra time spent, before embarking on such schemes, in ascertaining all the facts necessary for judging whether the proposals are likely to serve the purposes intended, may not only save unprofitable expenditure, but may also lead to the adoption of more practical measures.

The Late Mr. A. E. Cornwall-Walker

Water engineers will learn with deep regret of the death of Mr. Archibald Edward Cornwall-Walker, which took place, following a short illness, at his home, St. Arnaud, Doods Way, Reigate, on Sunday, August 14th, in his seventy-ninth year. Mr. Cornwall-Walker was the engineer and manager of the East Surrey Water Company for thirty-seven years. He was educated at St. Mark's School, Windsor, and St. George's School, Brampton, and served his pupilage with the late Mr. J. W. Restler, M.I.C.E. In 1890 he joined the Vauxhall Water Company; for seven years he carried out various works connected with that company's system. In 1897 Mr. Cornwall-Walker was appointed assistant engineer of the East Surrey Water Company, and in conjunction with the then engineer, Mr. J. R. Downes, A.M.I.C.E., he constructed filter beds at Reigate and the pumping station at Purley and also alterations to the Kenley pumping station. He was also joint engineer with Mr. Downes of the Worth and West Hoathly waterworks of the East Grinstead Rural District Council. In 1904 he was appointed engineer and manager of the East Surrey Water Company and was responsible for the construction of covered service tanks at Merstham and Caterham, and the installation of softening and lime tanks at the Purley pumping station. In 1925 he installed Sulzer oil engine driven pumps at Purley, and oil engine driven pumps were also put down at the Leatherhead pumping station. In 1922 he had been appointed the managing director of the East Surrey Water Company and two years later he was elected a director of the South Essex Water Company. In 1941 he retired from the managing directorship of the East Surrey Water Company, but remained on the board of the company until his death. His great work for the water supply industry was recognised in 1943 by the bestowal of the C.B.E. Mr. Cornwall-Walker was a member of the Institution of Civil Engineers and a member and Past President of the Institution of Water Engineers and the British Waterworks Association. His death will be regretted by many friends.

Institution of Mining and Metallurgy

In accordance with the revised by-laws recently allowed by the Privy Council, the Institution of Mining and Metallurgy has created a new class of membership, to be known as the affiliate class. This new class, it is claimed, provides for those members of the mining and metallurgical profession who have exceeded the qualifications for studentship, but are not yet able to comply with the more stringent conditions for admission to associate membership. It also meets the need for a new class of membership for those engaged in scientific and technical work, but who are members of other professions. Candidates who are members of the mining and metallurgical professions and wish to join the new class of affiliates should be persons whose professional experience is of the type which would qualify them for admission to associate membership, but who do not possess the requisite degree or diploma. It is possible for affiliates elected in this category to qualify for transference to associate membership by passing the Institution's examination. Those candidates for election as affiliates, who are not members of the mining and metallurgical professions, should be engaged in scientific and technical work connected with these professions. They should either hold a professional qualification or have reached a position of considerable responsibility. Suitable candidates would thus be civil, mechanical and electrical engineers, physicians and surgeons, physicists and chemists, economists and statisticians, accountants, mine secretaries, and salesmen who are qualified engineers. Other special cases will be considered on their merits. The Secretary of the Institution of Mining and Metallurgy, at Salisbury House, London, E.C.2, will be pleased to supply members with application forms, or to send forms to any persons whose names and addresses are supplied to him.

The Model Engineer Exhibition

On Wednesday last, August 17th, the Model Engineer Exhibition was opened at the New Horticultural Hall, Vincent Square, London, S.W.1, by Sir Frederick Handley Page, and will be open daily from 11 a.m. till 9 p.m. until Saturday, August 27th. Visitors to the exhibition will find that the models presented are as varied as before and maintain the high standards set in previous years. With each succeeding exhibition it is becoming more and more difficult to appreciate that the precise and beautiful workmanship evident in a very high percentage of the models can be effected by amateurs. The complications and difficulties which must have been overcome and the patience which must have been required in reproducing to scale some of the machines and equipment exhibited is evidence of the infinite enthusiasm and enterprise of the true model maker. Although this year's exhibition shows that locomotives and ships are still the most popular subjects of the model maker, automobiles and aeroplanes are being modelled in increasing numbers. Possibly this trend has been influenced to some degree by the introduction of the central arena, in which spectacular displays have been featured at the past two exhibitions. The judges for the competition section of the exhibition, in which awards are made for precision and ingenuity, have an unenviable task to perform with so much outstanding craftsmanship.

Passenger Transport in Glasgow

It is announced that the British Transport Commission has appointed a committee to report on the transport requirements of Glasgow and its adjacent areas and to make recommendations to the Commission. The chairman of the committee is Sir Robert Inglis, M.I.C.E., F.R.S.E., and its members include Mr. Robert Beveridge, general manager of Scottish Omnibuses, Ltd.; Mr. I. R. Fraser, assistant civil engineer, the Scottish Region, British Railways; Mr. F. A. Harper, formerly electrical engineer of the L.M.S. Railway and latterly of the Midland Region, British Railways; Mr. A. F. Moss, district operating superintendent, Glasgow, British Railways; and Mr. H. R. Statham, district commercial superintendent (passenger), Glasgow, British Railways. The committee will have regard to the future trend of commercial and residential development in and around Glasgow, and to the planning proposals of the local authorities, and of the Clyde Valley Regional Planning Advisory Committee. It will make recommendations to the British Transport Commission as to any improvements or developments of the present services and facilities, now controlled by the Commission, or by the Glasgow Corporation, which appear to be desirable or necessary in fulfilment of the policy of integration of inland transport, laid down by the Transport Act, 1947, having due regard to the financial return to be anticipated from any capital outlay involved. The appointment of the committee has been made with the concurrence of the Minister of Transport, who has consulted the Secretary of State for Scotland. The committee will work in close collaboration with the Corporation of Glasgow.

American Railroads

No. II—(*Continued from page 170, August 12th.*)

(*Contributed*)

PASSENGER RAILWAY TRAINS IN THE UNITED STATES

THE visitor entering the United States to-day and looking over the railroad time tables will be impressed—among other things—by the prominence given to train names. Here in Great Britain, the cradle of railroads, while we do not know what unofficial names may have been given to the earliest railway trains, it seems highly probable that the first officially named passenger train was the "Irish Mail," of the old L.N.W.R. We certainly enter the "Flying Scotsman" or the "Royal Scot" with an interest transcending what we would feel were they identified solely by the hour at which they leave King's Cross and Euston respectively. Now that our railways are nationalised, it may be hoped that the practice of naming trains will not only be continued, but extended. Indeed, there is greater inducement than ever before to cultivate any procedure likely to stimulate rail travel.

In the United States the privately owned railroads are said to operate no fewer than 695 named passenger trains, including 125 "streamliners." Examination of the names of these trains reflects the practical imagination with which they have been chosen, an imagination so exercised as to stamp the train with an individuality appropriate to the region through which it passes. How significant are the titles of those streamlined trains of the Gulf, Mobile and Ohio R.R., which connect Chicago with St. Louis. Traversing the districts of Illinois associated with the immortal name of Abraham Lincoln they are called, respectively, the "Ann Rutledge" and the "Abraham Lincoln."

The title "Empire State Express" illustrates just what is to be unfolded to the passenger as that fine train passes out of New York City, speeds along the banks of the Hudson and Mohawk rivers and traverses such towns as Albany, Schenectady, Utica, Syracuse, Rochester and Buffalo. Again, if the "Hiawathas" of the Chicago, Milwaukee and St. Paul were not outstanding examples of air-conditioned comfort, the very name would attract us, and as they fly through the well-watered dairy lands of Wisconsin, the "laughing water" is all round about us. While the railroads of the Middle West and West discover a romantic tendency in their choice of train names, very dignified and appropriate are the names of the trains which connect New York with Washington: "The President," "The Legislator," "The Representative," "The Judiciary," "The Senator," "The Executive," "The Washingtonian," "The Potamac," "The Patriot," and that crack Pennsylvanian express, "The Congressional."

One can suppose that in devising names for these splendid trains the executives get into what is called a "huddle" and come out with the appropriate title. The names are derived from all manner of sources. History, geography, zoology, literature, sport, ethnology, and other fields of human knowledge are searched for the significant description, and while it is not confirmed that the Trans-Florida Central Railroad operates a train officially known as the "Jitterbug," only students of Spanish literature would be able to appreciate the "Ponce de Léon" (train No. 312) of the New York Central System, operating between Detroit and Cincinnati. From the magnificent "Broadway Limited" of the Pennsylvania Railroad downward through the long list, we find allusions which unquestionably add interest to the journey and impart an ingredient of sentiment to the train. Thus, it is that the "feature" train is built up whether it be a Peoria "Rocket" or a California, Denver, Nebraska or Texas "Zephyr."

Not so familiar to British ears are the circumstances associated with the names of the "De Witt Clinton," the "James Whitcomb Riley," the "Commodore Vanderbilt" and the "Sam Houston," but who would not wish to travel in the "Mark Twain Zephyr"? The "Mohawk," the "Wolverine," the "Black Hawk" and the "Iroquois" would certainly be shorn of romance if listed only under their bare time table designations as "No. 5," "No. 17," "No. 47–53" and "No. 35." The older named trains such as the "Empire State Express" and the "Twentieth Century Limited" have long become part of American railway history and they share with newer trains that "New Look" which is so spectacular a feature of modern American rolling stock.

To passengers accustomed to the comparative austerity of European railway cars which correspond, in denomination, to day-coach in American streamlined trains, the Transatlantic conditions are truly amazing. One reposes on adjustable reclining seats (with adjustable foot rests) in air-conditioned, fluorescent-illuminated luxury. There is an entire absence of dust and dirt, draughts and smell. The vestibule end walls are enlivened by large-framed reproductions of paintings by such as Gainsborough and Sir Joshua Reynolds (*Vestibulum domus ornamentum est!*). From time to time ice cream, sandwiches, and such like, are conveyed through the aisle and dispensed under circumstances of transcendent cleanliness and courtesy.

Since no more than from forty-four to sixty seats are provided in these delightful day coaches, the tare weight, per passenger hauled, will not be less than about 1 ton and must frequently be a great deal more. This compares with, say, two and three-quarter passengers hauled per ton of tare weight in the new all-metal vestibuled third-class coaches of the Swiss Federal Railways, which are also built for high speed and have high-speed brakes. The Swiss coaches have not, of course, the superlative comfort of the American coach, they lack air-conditioning, and the austerity of the seating would be the occasion of acid comment by passengers accustomed to the "Hiawathas" or the "Zephyrs." At the same time, the Swiss coaches are extremely good and maintained in spotlessly clean condition. If they do not measure up to the æsthetic and comfort standards of the American coach, they are certainly not without their economic *raison d'être*.

The names given to long-distance passenger trains are, of course, part of the praiseworthy effort to render the American public railway train-minded, and who would not travel from New York to Washington in "The President," rather than in "No. 115"? Nevertheless, the mere naming of a train would not be of traffic-attracting value were it not associated with something material, something alluring in the train itself. The intensity of the efforts made in this direction can only be appreciated by surveying and enjoying the sheer comfort of those beautifully equipped and decorated vehicles. Never before has so much talent and activity been devoted to imparting æsthetic beauty to a railway train. This beauty is associated, moreover, with a degree of engineering skill which covers all aspects, whether in the design of the high-speed trucks, the admirable braking, the unapproached sanitation, the air-conditioning and the truly splendid equipment of the kitchens.

As an authentic illustration of the amenities provided in the United States, the following is taken from an official publication (1948) of the Chicago, Burlington and Quincy Railroad. It relates to that company's "Denver Zephyr," running nightly between Chicago and Denver:—

"The 'Denver Zephyr,' like a fine club or hotel, is notable for the distinctive diversements it affords. Popular among these is the gay, cosmopolitan cocktail lounge, where passengers from all parts of the train gather in smart and convivial surroundings. A quarter-circle bar, with a sparkling back-bar encompassing an illuminated etched glass mirror, occupies the forward end of the lounge. Intimate half-moon sofas and modernly designed leather covered chairs provide sociable seating arrangements. Green Venetian blinds cover the broad windows. An artistic metal grille separates the lounge proper from the annexe. A telephone connection with the diner facilitates the making of table reservations. A radio supplies musical background for this gay rendezvous." The C.B. and Q. time table further explains how "the 'Denver Zephyr' is propelled by electric power, generated by three V-type two-cycle oil-burning diesel engines developing a total of 3000 h.p. Each of these units may be operated independently of the others, and any one can be shut down for maintenance or repair without interrupting the operation of the train."

Lest the "Denver Zephyr" should be deemed something entirely unique, the following can be quoted from the current Baltimore and Ohio R.R. official timetable:

"Riding the 'Cincinnation' is like going to a party. For this is a gay and colorful train, with friendly lounges to visit, and a route that thrills you every mile of the way. And right in line with that 'party feeling' it gives you, are two of those famous B. and O. 'extras': delicious meals and old-fashioned courtesy. Make a date soon with this de luxe all-coach daylight streamliner!"

It may be explained that the "Cincinnation" (running between Baltimore-Washington and Cincinnati) went into service on January 19, 1947, and the time table states that while travelling nearly 1,000,000 miles, "the 'Cincinnation' has been on time 96·8 per cent." In this all-coach train the passenger can reserve in advance (free of charge) his "sleepy hollow" seat, and in addition to having access to the "coffee shoppe" car and the observation-lounge-diner, he may listen to the radio and have the services (if required) of the stewardess-nurse carried on the train.

Regarding railway personnel in the United States, it is characterised by an order of courtesy which is just as marked in the conductor, the steward who manages the dining car and in the engineer who manages the locomotive. The present writer was particularly impressed by the outstanding friendliness of the engineers. Whether the locomotive was steam, diesel-electric, or

electric, the engineer was always willing to furnish information, and there were times when he would hand down from the footplate a pair of gloves and ask the enquirer if he would like to climb up and have a look round. These American railway men are not only most friendly, but extremely well-informed, and their comments on railroad power units very illuminating. In the course of some thousands of miles of railroad travelling, the present writer experienced nothing but courtesy at the hands of all train personnel.

In respect of the catering, it can be described as in every way splendid, whether in the distribution—free on some occasions—of toasted peanuts, or in the delightful dining car meals. To sit in a tavern car with its large windows, soft carpets and comfortable chairs and listen (in an air-conditioned atmosphere) to the radio programme, makes one wonder how it can all be done at an average fare of 2½ cents per mile. Doubtless the American railroads are obliged, by intense competition, to attain a very high standard of passenger train comfort. Were it not so, passenger traffic would be in extreme peril and the railroads would quickly become purely freight lines. With the millions of private automobiles, innumerable aircraft and a nation-wide service by long-distance road buses, the American railroads have a hard battle in retaining the diminishing long-distance passenger traffic.

Surely there is, in all this, a lesson for the British Railways, particularly now that nationalisation has obliterated whatever might have been salutory in competition. Much can be learned from the railroads of the United States which is applicable on the railways of Great Britain, and a "Hiawatha" or a "Zephyr" between London and Glasgow would, for example, invigorate the Anglo-Scottish passenger services. Improvement should begin, however, with a higher standard of cleanliness and hygiene. No longer must it be necessary for a passenger, when in the lavatory compartments, to look in vain for water, soap and towels. A modern American long-distance day coach with accommodation for sixty-four passengers has four lavatory basins (all with mirrors), three toilets, ice water for drinking and an apparently inexhaustible supply of paper drinking cups and paper towels. The compartments containing these facilities (there are separate compartments for men and women) are, of course, air-conditioned, and they exhibit the following notice :—

"This is YOUR lavatory. We try to keep it clean for the benefit of all. Will you kindly help by

"(1) Depositing paper towels and other refuse in receptacles for used towels.

"(2) Wiping wash basin with paper towel after using."

The Mother of Railroads stands in stark need of rejuvenation, and while current shortages render it impossible to approach the catering standards reached on the railroads of the United States, cleanliness, sanitation and punctuality are features which should surely be characteristic of any State-owned railways as, indeed, they already are on the Swiss Federal Railways. Our British Railways traverse, without the handicap of level crossings, regions of great historic interest and singular æsthetic beauty. Their roadbeds are unsurpassed, their personnel has inherited vast experience based on a century and a quarter of operational history. Now is the time for all concerned to get into what the Americans call a "huddle" and do their utmost to attract passenger traffic.

It is not sufficient to copy one isolated feature of American practice. Indeed, "Ye olde Bull and Bush" public-house car appears to be a rather quaint travesty of the American "tavern" car which is nothing if not practical. We do not need to go back to such anachronisms as old lanterns and Tudor brickwork. What we want in a tavern car is comfortable seating, ample lighting and unexceptionable lavatories with separate compartments for men and women. We shall only succeed in making the public more train-minded by the exercise of that practical imagination, ingenuity and enthusiasm which are so manifest in the operation of the railroads of the United States.

(To be continued)

Behaviour of Cast Steel at Elevated Temperatures*

By A. E. JOHNSON, M.Sc., A.M.I. Mech. E.†

No. IV—*(Continued from page 168, August 12th)*

The Nature of the Anisotropy at the Highest Stresses at 450 deg. Cent.—As previously stated, the nature of the anisotropy at the highest stresses at 450 deg. Cent. is similar to that at corresponding stresses at 350 deg. Cent., and arises from the same cause, high initial plastic strain.

At these stresses it completely masks the basic anisotropy mentioned in the previous paragraph. The equations are of the same type as at 450 deg. Cent., viz.,

$$C_1=F(\Sigma(\sigma_1-\sigma_2)^2)\{(\sigma_1-\sigma_2)-(\sigma_2-\sigma_1)\}$$
$$C_2=F(\Sigma(\sigma_1-\sigma_2)^2)\{B(\sigma_2-\sigma_3)-(\sigma_1-\sigma_2)\}$$
$$C_3=F(\Sigma(\sigma_1-\sigma_2)^2)\{(\sigma_2-\sigma_1)-B(\sigma_2-\sigma_3)\}$$

where for values of $p/q=0\cdot4$, $0\cdot8$ and $1\cdot25$, B has the value $1\cdot5$, $1\cdot7$ and $3\cdot5$.

(10.1.2) *At 550 deg. Cent.*—It has already been stated that considerable anisotropy of the material occurs at 550 deg. Cent., and that the indication was that this anisotropy was of a most complex nature, probably not easily susceptible to analytical representation. This proved to be the case, and no reasonably simple forms of equation appeared to conform with the whole of the experimental results.

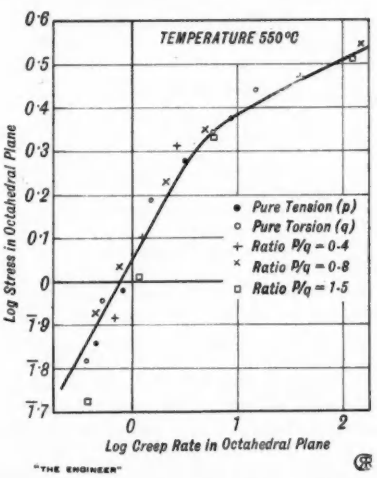


FIG. 18—*Log. Octahedral Shear Stress—Log. Octahedral Creep Rate Curves for All Stress Systems at 100 Hours*

The curve shown corresponds to the principal plane equations

$$\text{Creep rate}=\{A+A'[\Sigma(\sigma_1-\sigma_2)^2]^4\}\,[(\sigma_1-\sigma_2)^{2\cdot1}-(\sigma_3-\sigma_1)^{2\cdot1}],\ \text{&c., where } A=5\cdot5\times10^{-8},\ A'=0\cdot8\times10^{-14}$$

However, the stress/strain plots for the octahedral plane were carried out as at 350 deg. and 450 deg. Cent., and the results did give an indication of the basic type of equation which, with suitable modification, might presumably be made to represent the anisotropic state of the material.

In Fig. 18 a plot of log. octahedral stress against octahedral creep rate is made. It is seen that, despite the considerable anisotropy known to exist in the material at this temperature, the experimental points lie reasonably well disposed round a common curve, indicating that even in these conditions some approximation to the behaviour of the material may be obtained by assumption of the Hencky criterion.

For the lower range of stresses the curve is linear of slope $2\cdot1$.

The whole curve shown in Fig. 18 is the log. plot for σ_0 against

$$C_0=2/3\{A+A'[\Sigma(\sigma_1-\sigma_2)^2]^4\}\{\Sigma[2(\sigma_1-\sigma_2)^{2\cdot1}-(\sigma_3-\sigma_1)^{2\cdot1}-(\sigma_2-\sigma_3)^{2\cdot1}]^2\}^{\frac{1}{2}},$$

where $A=5\cdot5\times10^{-8}$ and $A'=0\cdot81_5\times10^{-14}$. It is probable that a value of C_0

$$=2/3\{A[\Sigma(\sigma_1-\sigma_2)^2]^{0\cdot55}+A'[\Sigma(\sigma_1-\sigma_2)^2]^{4\cdot55}\}\{\Sigma[2(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)-(\sigma_2-\sigma_3)]^2\}^{\frac{1}{2}}$$

with A and A' suitably adjusted would give an equally good representation.

These two values of C_0 correspond to the principal plane equations

$$C_1=\{A+A'[\Sigma(\sigma_1-\sigma_2)^2]^4\}[(\sigma_1-\sigma_2)^{2\cdot1}-(\sigma_3-\sigma_1)^{2\cdot1}]$$

&c., and

$$C_1=\{A[\Sigma(\sigma_1-\sigma_2)^2]^{0\cdot55}+A'[\Sigma(\sigma_1-\sigma_2)^2]^{4\cdot55}\}[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)],$$

&c., becoming

$$C_1=A[(\sigma_1-\sigma_2)^{2\cdot1}-(\sigma_3-\sigma_1)^{2\cdot1}]$$

&c., and

$$C_1=\{A[\Sigma(\sigma_1-\sigma_2)^2]^{0\cdot55}\}[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)],$$

&c., at lower stresses.

It would appear, therefore, that the above equations are quite probably the isotropic bases which, with appropriate modifications, could be used to give some representation of the anisotropic behaviour at 550 deg. Cent. of this material. This is, however, only conjecture.

In Fig. 12 the plot of the stress function

$$-\sigma_2/(\sigma_1-\sigma_2)$$

against $-C_3/C_1$ shows the very considerable divergence of the experimental points at high ratios of p/q from the curve corresponding to the isotropic equation

$$C_1=A[(\sigma_1-\sigma_2)^{2\cdot1}-(\sigma_3-\sigma_1)^{2\cdot1}].$$

(10.2) *Values of Major Principal Creep Rate for Specific Values of Principal Stresses at 450 deg. Cent.*—In Fig. 19, for a range of values of the major principal stress σ_1, having values of σ_2 ranging from $\sigma_2=\sigma_1$, through $\sigma_2=-\sigma_1$, the log. major principal creep rate is plotted, computed on the basis of the experimentally derived equations

$$C_1=\{A+A'[\Sigma(\sigma_1-\sigma_2)^2]^2\}[(\sigma_1-\sigma_2)^{1\cdot9}-1\cdot5(\sigma_3-\sigma_1)^{1\cdot9}],$$

&c., where $A=0\cdot6\times10^{-8}$, $A'=2\times10^{-13}$ and $\sigma_3=0$.

Much the same curve would, of course, have been obtained if either of the other

* Report J/T 137, The British Electrical and Allied Industries Research Association. The full title is "The Behaviour of a Nominally Isotropic 0·17 per cent C Cast Steel Under Combined Stress Systems at Elevated Temperatures."

† National Physical Laboratory.

two equations given in Table II had been used.

The diagram has the same features as those shown in Fig. 18 for 350 deg. Cent. and serve the same purpose.

(11) *General Conclusions.*—For the 0·17 per cent C steel over the temperature range 350 deg. to 550 deg. Cent. the following conclusions have been reached :—

(1) The behaviour of the steel was essentially isotropic at all except the highest stresses in the tests at 350 deg. Cent.

At 450 deg. Cent. relatively simple anisotropy was shown at all except the highest stresses. At these later stresses the anisotropy occurring was as at 350 deg. Cent. apparently due to high initial plastic strain.

At 550 deg. Cent. a very complex condition of isotropy occurred. It appears possible that anisotropy exhibited at 450 deg. Cent. and 550 deg. Cent. is associated with changes occurring in the ferrite-pearlite structure of the material at these temperatures, possibly resulting in the conferment of directional creep properties.

(2) At 350 deg. Cent. the octahedral shear strain appeared for all stress systems to be a definite function of the octahedral shear stress, i.e., the Hencky criterion of plastic strain appeared to be fulfilled approximately for the material.

(3) The principal creep rate/stress relations at a specific period over the whole range of stress and time investigated (with the exception of the highest stresses), may reasonably be represented by equations of the form

$$C_1=\{A[\Sigma(\sigma_1-\sigma_2)^2]+A'[\Sigma(\sigma_1-\sigma_2)^2]^m\}\{(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)\}$$

&c., where A, A' and m are constant.

These equations conform equally with the simple and generalised St. Venant and also the Bailey theories.

At the highest stresses the equations assume the form

$$C_1=F[\Sigma(\sigma_1-\sigma_2)^2]\,[(\sigma_1-\sigma_2)-(\sigma_2-\sigma_1)]$$
$$C_2=F[\Sigma(\sigma_1-\sigma_2)^2]\,[B(\sigma_2-\sigma_3)-(\sigma_1-\sigma_2)]$$
$$C_3=F[\Sigma(\sigma_1-\sigma_2)^2]\,[(\sigma_3-\sigma_1)-B(\sigma_2-\sigma_3)]$$

where F is a function and B a constant.

(4) If the Hencky theory of plastic strain holds for an isotropic material, it may be shown that the applied stress p, and the applied torsion stress q, under any given complex stress system consisting of a simple tensile and a simple torsion stress, required to produce a specific octahedral creep rate, are related by the equation $p^2/P^2+q^2/Q^2=1$, where P and Q are the pure tensile and pure torsion stresses respectively required to produce the specific creep rate when applied singly. This relation was found to hold with reasonably good approximation for the present material at 350 deg. Cent.

(5) At 450 deg. and 550 deg. Cent., despite the anisotropy present, it appeared probable that the Hencky theory was still the basis of the behaviour of the material. At 450 deg. Cent., however, for all except the highest stresses, the anisotropy rendered the principal rate, stress and time relations rather more complex than those indicated for 350 deg. Cent. in (3) above.

Anisotropic versions of both the Marin and Soderberg, and also the Bailey equations gave reasonable arithmetical fits of the results.

The Marin and Soderberg equations could be expressed in the form

$$C_1=\{A[\Sigma(\sigma_1-\sigma_2)^2]^{m_1}+A'[\Sigma(\sigma_1-\sigma_2)^2]^{m_2}\}\,[(\sigma_1-\sigma_2)-(\sigma_2-\sigma_3)]$$

&c., or alternatively

$$C_1=\{A[(\sigma_1-\sigma_2)^2+C(\sigma_2-\sigma_3)^2+C(\sigma_3-\sigma_1)^2]^{m_1}+A'[(\sigma_1-\sigma_2)^2+C(\sigma_2-\sigma_3)^2+C(\sigma_3-\sigma_1)^2]^{m_2}\}\,[(\sigma_1-\sigma_2)-C(\sigma_2-\sigma_3)]$$

where A, A', C, m_1, m_2 are constants, C referring to the anisotropy present.

The Bailey equations could be expressed in the form

$$C_1=\{A+A'[\Sigma(\sigma_1-\sigma_2)^2]^m\}[(\sigma_1-\sigma_2)^n-D(\sigma_2-\sigma_3)^n]$$

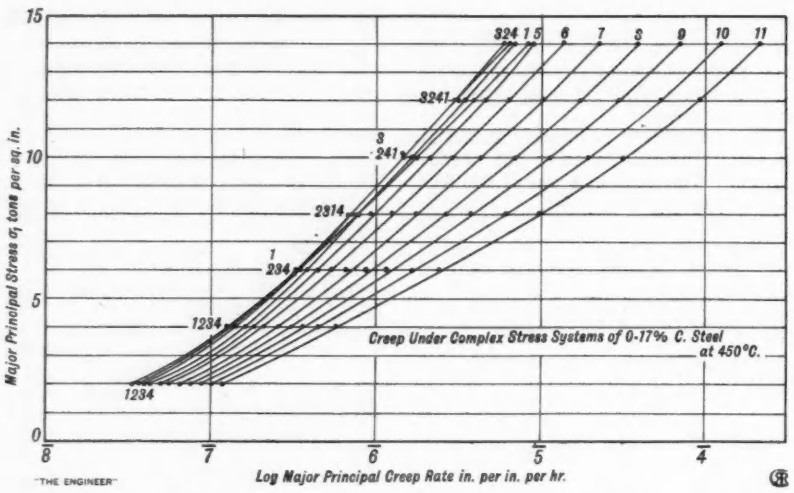


FIG. 19—*Major Principal Stress—Major Principal Creep Rate for Various Values of the Minor Principal Stress and Based on the Equation* $C_1=[A+A'\{\Sigma(\sigma_1-\sigma_2)^2\}^2]\,[(\sigma_1-\sigma_2)^{1\cdot9}-1\cdot5(-\sigma_1)^{1\cdot9}]$, *where* $A=0\cdot6\times10^{-8}$, $A'=2\times10^{-13}$, $\sigma_3=0$

(1) $\sigma_2=\sigma_1$	(5) $\sigma_2=0\cdot2\sigma_1$	(9) $\sigma_2=-0\cdot6\sigma_1$
(2) $\sigma_2=0\cdot8\sigma_1$	(6) $\sigma_2=0$ (Pure tension)	(10) $\sigma_2=-0\cdot8\sigma_1$
(3) $\sigma_2=0\cdot6\sigma_1$	(7) $\sigma_2=-0\cdot2\sigma_1$	(11) $\sigma_2=-\sigma_1$ (Pure torsion)
(4) $\sigma_2=0\cdot4\sigma_1$	(8) $\sigma_2=-0\cdot4\sigma_1$	

Nomenclature

Applied tensile stress	p
Applied torsion stress	q
Major principal stress	σ_1
Minor principal stress	σ_3
Secondary principal stress	$\sigma_2=0$ in all tests
Axial creep rate	C_a
Circumferential creep rate	C_c
Creep rate in direction of major principal stress	C_1
Creep rate in direction of minor principal stress	C_3
Creep rate in direction of secondary principal stress	C_2
Time	t
Angle between direction of major principal stress and axis of specimen	ϕ
Ratio q/p	a
Quantity $\sqrt{1+4a^2}$	b
Octahedral shear stress	σ_0
Octahedral shear creep rate	C_0
Principal strains	ϵ_1, ϵ_2, ϵ_3

where n and D are constants, D referring to the anisotropy present.

At the highest stresses at 450 deg. Cent. the stress creep rate equations assume the same general form as arose at corresponding stresses at 350 deg. Cent.

At 550 deg. Cent. a complex state of anisotropy arises and it is not possible to formulate general equations representing the stress, rate relations. There is some evidence, however, that the basis of such equations would be similar to the general forms given above for 350 deg. and 450 deg. Cent.

(12) *Appendices :* (12.1) *Stress/Strain Relations for Plastic Flow of Isotropic Metals.*—The great majority of the theory so far advanced both for time-independent plastic strain and time-dependent creep strain is based on four principles which are assumed applicable to isotropic materials.

These are :

(1) The principal axes of stress, and of strain, are coincident, and remain so during plastic strain. This is generally regarded as closely true for plastic strain up to moderately large amounts.

(2) The volume of the material remains unchanged during plastic strain.

(3) The three principal shear strains are proportional to the three principal shear stresses.

(4) That plastic strain or yielding follows the criterion of shear strain energy or octahedral shear stress. The majority of experimental work available supports this contention.

If ϵ_1, ϵ_2, ϵ_3 be the principal strains, and σ_1, σ_2, σ_3 the principal stresses :

The first three relations can be expressed by the following equations :—

$$\epsilon_1+\epsilon_2+\epsilon_3=0 \quad . \; . \; . \quad (1)$$

$$\frac{(\epsilon_1-\epsilon_2)}{(\sigma_1-\sigma_2)}=\frac{(\epsilon_2-\epsilon_3)}{(\sigma_2-\sigma_3)}=\frac{(\epsilon_3-\epsilon_1)}{(\sigma_3-\sigma_1)}=C \quad (2)$$

To conform with the relation (1) C must be either an arithmetic constant or an invariant of the stress system.

Combinations of (1) with (2) result in principal stress/strain equations of the type :

$$\epsilon_1=\frac{C}{3}[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)],\ \&c.$$
$$=A[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)],\ \&c. \quad . \; . \quad (3)$$

A is either an arithmetic constant or an invariant of the stress system. The above relations are those attributed to St. Venant.

The St. Venant theory is capable of generalisation if it be assumed that the shear strains $(\epsilon_1-\epsilon_2)$, &c., are proportional to a function of the maximum shear stresses, i.e.,

$$\frac{(\epsilon_1-\epsilon_2)}{f(\sigma_1-\sigma_2)}=\frac{(\epsilon_2-\epsilon_3)}{f(\sigma_2-\sigma_3)}=\frac{(\epsilon_3-\epsilon_1)}{f(\sigma_3-\sigma_1)}=C \quad . \quad (2a)$$

where f denotes a function.

Expansion of $f(\sigma_1-\sigma_2)$, &c., in terms of power series leads to the indication that terms of the first and third order only explicitly fit this relation or that the form of ϵ_1, &c., should be in general

$$\epsilon_1=A[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)]+B[(\sigma_1-\sigma_2)^3-(\sigma_3-\sigma_1)^3]$$
$$=A[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)]=\{1+A'[\Sigma(\sigma_1-\sigma_2)^2]\} \quad . \; . \; . \; . \quad (4)$$

Other principal stress strain relations have been suggested or are possible. These, while conforming with principles (1) and (2), do not conform with the St. Venant equation (2) in either its simple or generalised form. These further equations are of the general form

$$\epsilon_1=A[(\sigma_1-\sigma_2)^n-(\sigma_3-\sigma_1)^n],\ \&c. \; . \; . \quad (5)$$

and

$$\epsilon_1=A[e^{K(\sigma_1-\sigma_2)^2}-e^{K(\sigma_3-\sigma_1)^n}]\ \&c. \; . \quad (6)$$

where $\sigma_1>\sigma_2>\sigma_3$ and where A may be an arithmetic constant or an invariant. They are based generally on the basic assumptions that creep occurs on all planes where there is

shear stress, and is not confined to planes of maximum shear stress, and that creep by shear upon a plane may be influenced by shear stresses upon other planes.

Equation (5) may be generalised, of course, in the form

$$\epsilon_1 = A[(\sigma_1-\sigma_2)^n-(\sigma_3-\sigma_1)^n]+B[(\sigma_1-\sigma_2)^N-(\sigma_3-\sigma_1)^N]+\ldots\ldots \quad (7)$$

which is always such that $\Sigma\epsilon_1=0$.

The equations cited above cover the types of relationship normally thought to exist under conditions of creep or time independent flow.

By replacing principal strains ϵ_1, ϵ_2 and ϵ_3 by C_1, C_2 and C_3 the principal creep rates, the above equations become directly applicable to creep conditions.

To obtain the form of function A, use can be made of the fourth principle by comparing the exponential relations between the shear stress and the shear strain in the octahedral planes. In these planes shear strain only occurs, and is proportional to the resultant of the distortional shear strains, the shear stress being proportional to the shear strain energy or resultant of the distortional shear stresses.

Equation (3), considered in relation to the fourth principle, the plastic flow cited above becomes in general

$$F\{[(\sigma_1-\sigma_2)^2]^{\frac{1}{2}}[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)]$$

where F denotes a function.

Equations advanced by Odquvist, Marin and Soderberg are of this type. Odquvist obtained the form

$$C_1 = A[\Sigma(\sigma_1-\sigma_2)^2]^m[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)],$$

while Marin and Soderberg, accepting the experimental fact that creep rate varies as stress to some power (n), and considering the rate of dissipation of shear energy as the criterion of performance, obtained the form

$$C_1 = \frac{A}{2^{\frac{(n+1)}{2}}}[\Sigma(\sigma_1-\sigma_2)^2]^{\frac{n-1}{2}}[(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)]$$

&c.

Nadai regarded A as in effect a variable viscosity function, dependent on the stress system and expressed as

$$C_1 = \frac{(\sigma_1-\sigma_2)-(\sigma_3-\sigma_1)}{\phi}$$

&c., where ϕ is the viscosity coefficient. Consideration of equation (5) in relation to the fourth principle of plastic flow leads to the form

$$C_1 = F\{[\Sigma(\sigma_1-\sigma_2)^2]^{\frac{1}{2}}\}[(\sigma_1-\sigma_2)^n-(\sigma_3-\sigma_1)^n],\ \&c.$$

The equations advanced by Dr. R. W. Bailey, based on the results of his experimental work, are of this type. They are

$$C_1 = \frac{A}{2}[\tfrac{1}{2}\Sigma(\sigma_1-\sigma_2)^2]^m\{(\sigma_1-\sigma_2)^n-(\sigma_3-\sigma_1)^n\},\ \&c.$$

Equation (6), in conjunction with the fourth principle, leads to equations of the form

$$C_1 = F\{[\Sigma(\sigma_1-\sigma_2)^2]^{\frac{1}{2}}\}[e^{K(\sigma_1-\sigma_2)^n}-e^{K(\sigma_3-\sigma_1)^n}]$$

This latter equation, however, leads to unsatisfactory results in the case of the secondary and minor creep rates in pure tension, and on that account cannot be recommended. It should be noted that

$$F[\Sigma(\sigma_1-\sigma_2)^2]$$

may, of course, be a composite function of $\Sigma(\sigma_1-\sigma_2)^2$, such as

$$A+A'[\Sigma(\sigma_1-\sigma_2)^2]^m+A''[\Sigma(\sigma_1-\sigma_2)^2]^M+\ldots$$

In the experimental work described in this paper this type of function apparently occurs, the equations being of general form

$$C_1 = \{A+A'[\Sigma(\sigma_1-\sigma_2)^2]^m\}[(\sigma_1-\sigma_2)^n-(\sigma_3-\sigma_1)^n],$$

&c.

The most general equation of the Bailey type may therefore be written

$$C_1 = \{A+A'[\Sigma(\sigma_1-\sigma_2)^2]^m+\ldots\}[(\sigma_1-\sigma_2)^n-(\sigma_3-\sigma_1)^n]+\{B+B'[\Sigma(\sigma_1-\sigma_2)^2]^{m'}+\ldots\}[(\sigma_1-\sigma_2)^N-(\sigma_3-\sigma_1)^N]+\ldots$$

To conform with the St. Venant simple or generalised relations, n and N in the above general equations must be of value either 1 or 3, and only one invariant expression

$$\{A+A'[\Sigma(\sigma_1-\sigma_2)^2]^3+\ldots\}$$

may be used.

It is possible by means of using these generalised relations to simulate the geometrical form of the curve representing a wide range of experimental stress creep rate relations.

(12.2) *The Theoretical Relations Between the Ratios C_a/C_c and p/q for Creep Conditions of an Isotropic Metal.*— We have

(*a*) $C_1 = C_a+\frac{C_c}{2}\left(\sqrt{(p/2q)^2+1}-p/2q\right)$

(*b*) $C_2 = C_a-\frac{C_c}{2}\left(p/2q+\sqrt{(p/2q)^2+1}\right)$

(*c*) $C_3 = C_c p/2q-2C_a$

(*d*) and the equations

$$C_1 = A[(\sigma_1-\sigma_2)^n-(\sigma_3-\sigma_1)^n]$$

&c., where A may be an invariant of the system. From (*a*) and (*b*)

$$(C_1-C_2) = C_c\left(\sqrt{(p/2q)^2+1}\right) = \frac{C_c(\sigma_1-\sigma_2)}{2q}$$

since

$$\frac{\sigma_1}{\sigma_2} = p/2 \pm \tfrac{1}{2}\sqrt{p^2+4q^2}\ .$$

Thus

$$C_c = 2q\frac{(C_1-C_2)}{(\sigma_1-\sigma_2)}$$

also

$$C_a = \frac{-C_3}{2}+C_c p/4q$$

$$\frac{C_a}{C_c} = p/4q\frac{-C_3}{4q}\frac{(\sigma_1-\sigma_2)}{(C_1-C_2)} = p/4q+\frac{(C_1+C_2)}{(C_1-C_2)}\frac{(\sigma_1-\sigma_2)}{4q}$$

$$= p/4q+\frac{(\sigma_1^n+\sigma_2^n)\ (\sigma_1-\sigma_2)}{\left(2(\sigma_1-\sigma_2)^n+\sigma_1^n-\sigma_2^n\right)}\times\frac{1}{4q}\ .$$

If we make $q/p=a$ and $\sqrt{1+4a^2}=b$ this becomes

$$\frac{C_a}{C_c} = \frac{1}{4a}\left\{\frac{[(1+b)^n+(1-b)^n]b}{[2^{n+1}b^n+(1+b)^n-(1-b)^n]}+1\right\}$$

If $n=1$ this simplifies to $C_a/C_c=p/3q$.

(12.3) *The Relation Between the Applied Tensile Stress (p) and the Applied Torsion Stress (q) for Specific Octahedral Creep Rates and Specific Major Principal Creep Rates of an Isotropic Metal:* (12.3.1) *Specific Octahedral Creep Rates.*—Plotting of experimental results indicates that the octahedral creep rate is a unique function of the octahedral stress. Thus, for all combinations of p and q for a specific octahedral creep rate there must be a unique value of the octahedral stress$=1/3\sqrt{\Sigma(\sigma_1-\sigma_2)^2}$. This corresponds to differing values of σ_1, σ_2, p and q for each stress system. If $\sigma_3=0$ we have

$$\sigma_1 = p/2(1+\sec 2\phi)$$
$$\sigma_2 = p/2(1-\sec 2\phi)$$
$$(\sigma_1-\sigma_2) = p\sec 2\phi$$

and

$$\Sigma(\sigma_1-\sigma_2)^2 = \frac{p^2}{4}(6\sec^2 2\phi+2)$$
$$= \frac{p^2}{4}[6(1+\tan^2 2\phi)+2]$$
$$= 2p^2+6q^2.$$

The octahedral shear stress

$$= \frac{\sqrt{2}}{3}\sqrt{p^2+3q^2}$$
$$= \frac{\sqrt{2}}{3}t\sqrt{1+3a^2}$$

where $p/q=a$.

Thus, if the value of the octahedral stress$=K$, for any specific octahedral creep rate the operatives p and q are as follows:—

$$p = \frac{3K}{\sqrt{2(1+3a^2)}} \text{ and } q = \frac{3Ka}{\sqrt{2(1+3a^2)}}$$

For pure tension $P=3/\sqrt{2}K$. For pure torsion $Q=3K/\sqrt{6}$.

Then

$$\frac{p^2}{P^2}+\frac{q^2}{Q^2} = \frac{1}{(1+3a^2)}+\frac{3a^2}{(1+3a^2)} = 1.$$

Also, since $P=\sqrt{3}Q$, we have

$$\frac{p^2}{P^2}+\frac{3q^2}{P^2} = 1$$

or

$$\frac{p^2}{3Q^2}+\frac{q^2}{Q^2} = 1.$$

Thus, for corresponding specific octahedral creep rates the relation between p and q is elliptical, and this applies throughout the whole range of stresses.

(12.3.2) *Specific Major Principal Creep Rates.*—For specific principal creep rates we have in general for equations of the type

$$C_1 = A((\sigma_1-\sigma_2)^n-(\sigma_3-\sigma_1)^n) \text{ if } \sigma_3=0$$
$$(\sigma_1-\sigma_2)^n+\sigma_1^n = 2P^n = (1+2^n)Q^n,$$

where P is the pure tensile and S the pure torsion stress corresponding to the specific principal creep rate. Let $q/p=a$, then we have

$$(\sigma_1-\sigma_2)^n+\sigma_1^n$$
$$= (p^2+4a^2p^2)^{n/2}+(p/2+\tfrac{1}{2}\sqrt{p^2+4a^2p^2})^n$$
$$= p^n\left\{(1+4a^2)^{n/2}+\frac{1}{2^n}(1+\sqrt{1+4a^2})^n\right\}$$
$$= \frac{q^n}{a^n}\left[(1+4a^2)^{n/2}+\frac{1}{2^n}(1+\sqrt{1+4a^2})^n\right].$$

For pure tension $a=0$, and

$$(\sigma_1-\sigma_2)^n+\sigma_1^n = 2P^n.$$

For pure torsion

$$(\sigma_1-\sigma_2)^n+\sigma_1^n = Q^n(2^n+1).$$

Thus, we have

$$\frac{p^n}{P^n} = \frac{2}{\left[(1+4a^2)^{n/2}+\frac{1}{2^n}(1+\sqrt{1+4a^2})^n\right]}$$
$$\frac{q^n}{Q^n} = \frac{(1+2^n)a^n}{\left[(1+4a^2)^{n/2}+\frac{1}{2^n}(1+\sqrt{1+4a^2})^n\right]}.$$

Then

$$\frac{p^n}{P^n}+\frac{q^n}{Q^n} = \frac{(1+2^n)a^n+2}{\left[(1+4a^2)^{n/2}+\frac{1}{2^n}(1+\sqrt{1+4a^2})^n\right]}.$$

which is an nth degree general conic. Thus, no elliptical relation between applied p and q holds for specific major principal creep rates.

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HYDRO-ELECTRIC POWER PLANTS IN CENTRAL FRANCE

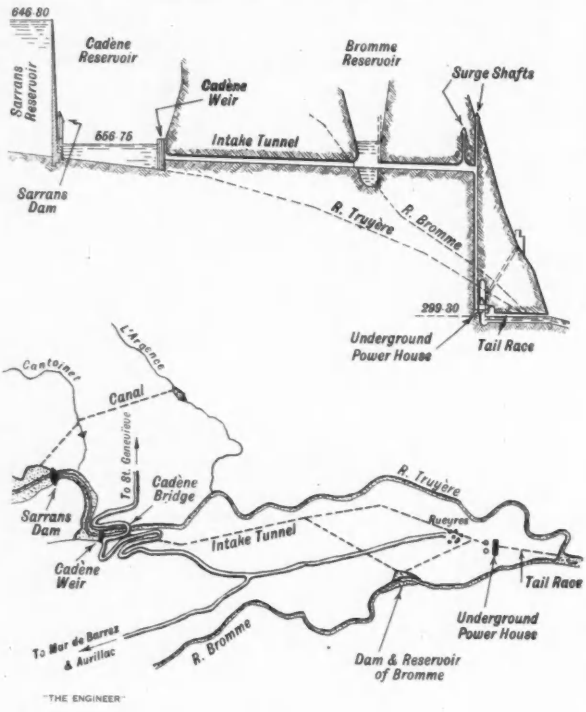

FIG. 1—PLAN AND PROFILE OF SARRANS AND BROMME WORKS

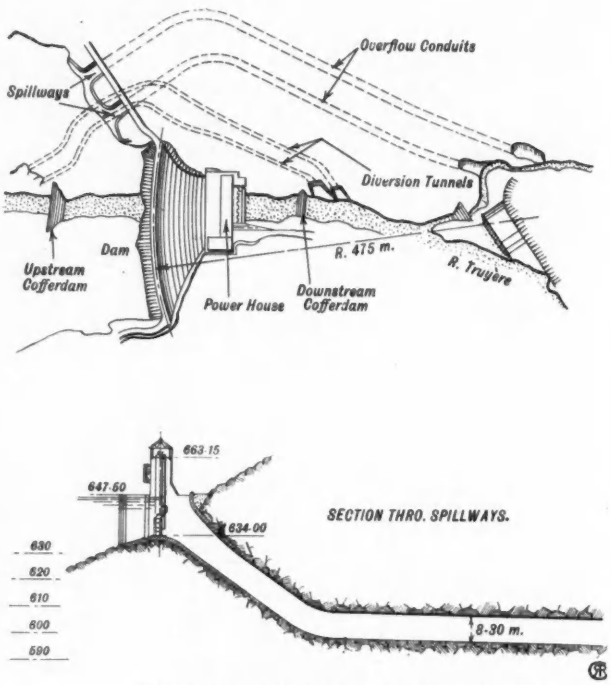

FIG. 2—SARRANS DAM AND POWER STATION

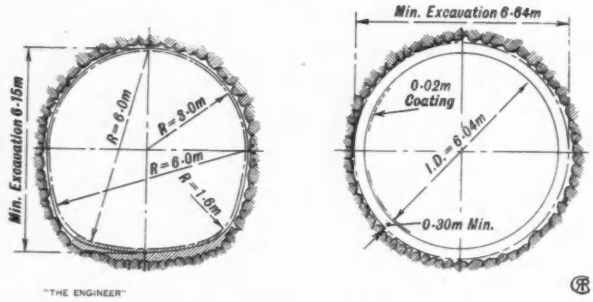

FIG. 3—CADENE TUNNEL—UNLINED AND LINED

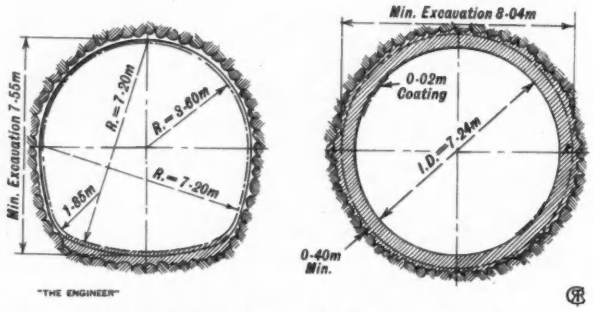

FIG. 4—BROMME TUNNEL—UNLINED AND LINED

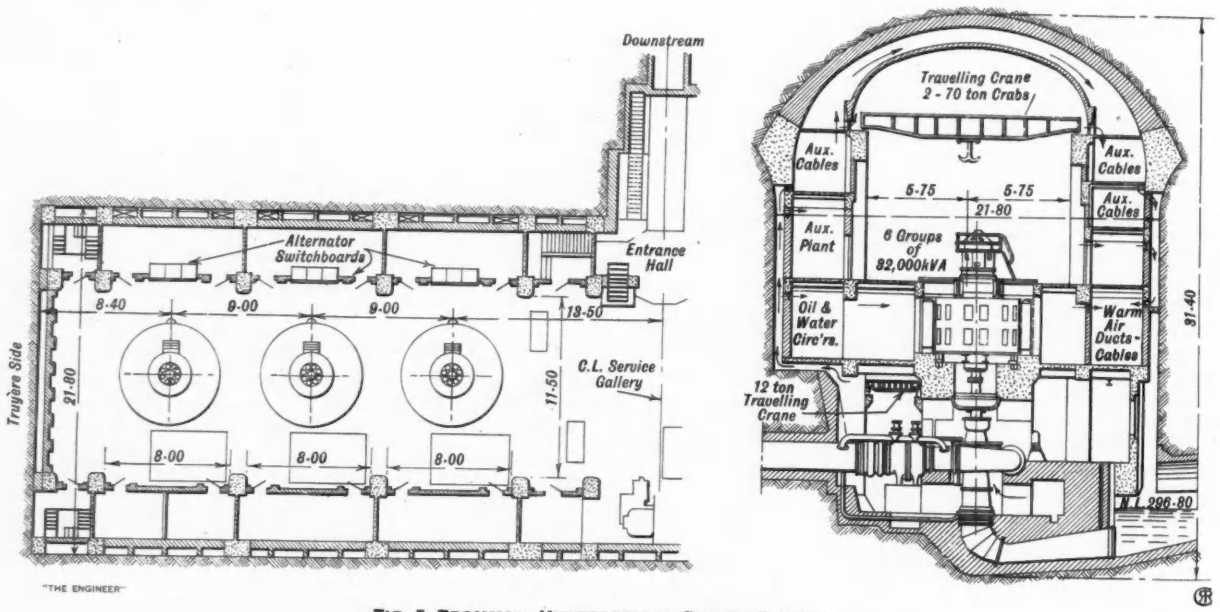

FIG. 5—BROMMAT UNDERGROUND POWER STATION

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[18] Utilisation of creep test data, page 267.

[19] It should be noted that for the anisotropic state indicated above, the relation $C_0=f(\sigma_0)$ is not accurately complied with. It holds nevertheless as a very good approximation (maximum error about 4 per cent).

Hydro-Electric Power Plants in Central France

No. I

By Dipl.-Ing. C. CARTY

THE volcanic origin of the mountainous region of Central France called the "Massif Central" is fairly well known. The streams of the western slopes of this region have cut deep and generally uninhabited gorges in the local rock, which consists mostly of gneiss, granite and mica slate. The rainfall is heavy. To these geological, geographical and meteorological advantages must further be added the fact that the seasonal variations allow a very efficient combination of the power production of the "Massif Central" with that of the Alps and the Pyrenees. This combination is possible because, whereas the production of the Alps and the Pyrenees is low in the winter, rising gradually during the spring and reaching a maximum during the summer for snow-fed rivers, the precipitation in the "Massif Central" takes place mainly during a well-characterised rainy season which lasts from November to April and even until May, with maximum falls in March/April. The dry season extends from May to October with minimum values in July/August. These conditions, and the heavy variations in flow they entail, call for the provision of dams and reservoirs, sometimes of considerable length and size.

Heads rarely exceed 600ft, so that all the main turbines of the power stations described are of Francis type with vertical shafts. Reading from south to north, the streams considered in this article, with their power plants at present either in service or in the course of construction, are the river Truyère and some of its tributaries, the river Cère, the Maronne and the Dordogne. Maps, Figs. 6 and 7, show their situation.

The Truyere River

This river has its source in the Lozère Department. Further on it flows through the Department of Cantal and ultimately joins the River Lot at the old city of Entraygues, in the Aveyron Department; some 15 miles north of this city is the confluence of the Truyère with its tributary the Bromme. Over a distance of 8 miles upstream from this latter point the Truyère shows a drop in level of 853ft, which is used in the power plants of Sarrans and Brommat, as described below and illustrated in Fig. 1.

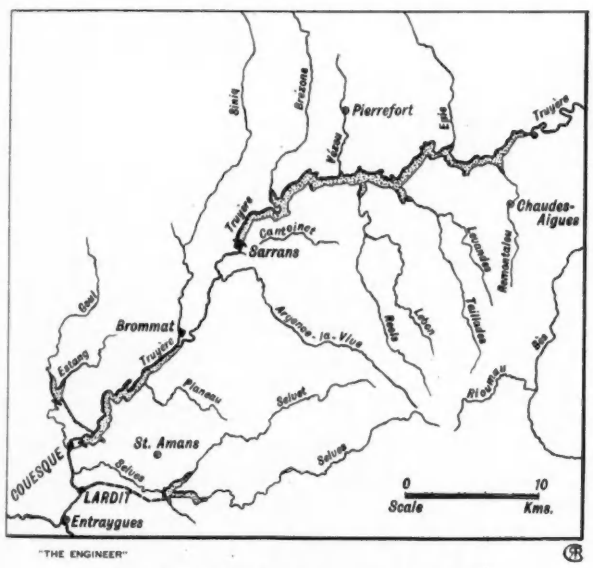


FIG. 6—POWER PLANTS ON THE TRUYERE

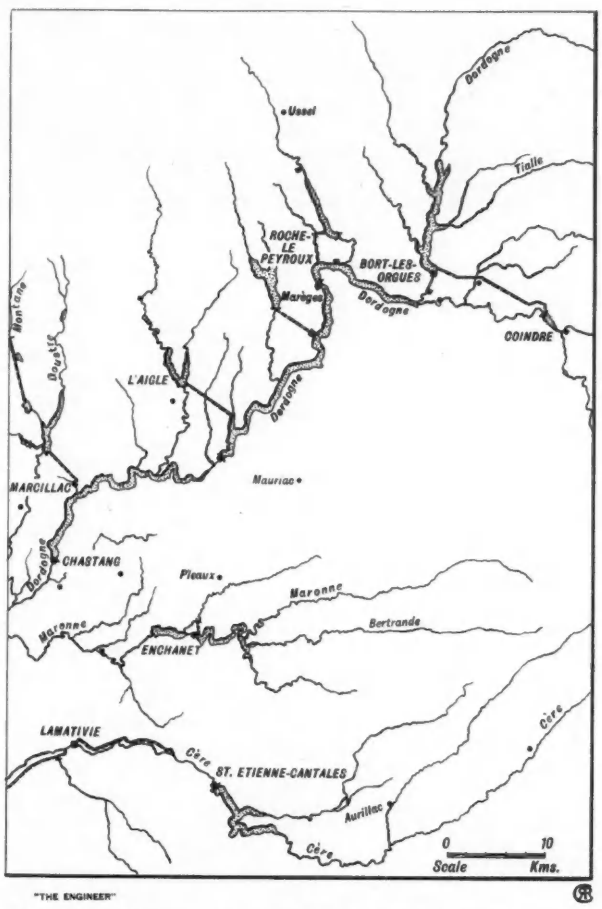


FIG. 7—POWER PLANTS ON THE DORDOGNE, MARONNE AND CERE

The Sarrans Dam

The Sarrans dam, at the head of the sharp drop in the level of the Truyère, is slightly curved in plan along a radius of 1560ft. It is of gravity type with a triangular cross-section and is situated in a narrow defile of the Truyère valley, the left bank of which, a sheer cliff nearly 500ft high, is used as an abutment for the dam—Figs. 2, 8, 10.

The volume of concrete in the dam is 590,000 cubic yards, made up of 600,000 tonnes of crushed stone aggregate, 400,000 tonnes of sand and 100,000 tonnes of cement. The height of the dam is 345ft above stream level and 370ft above foundation level, the thickness at the base varying between 246ft and 295ft. The developed length at the crest is 722ft, and a roadway runs over the crown at a height of 651m. H.W. level has been fixed at 646·80m (2122ft a.D.), which allows a storage of 296,000,000 cubic metres, of which 256,000,000 cubic metres are available for power production. When full, the storage basin forms an artificial lake some 22 miles long, covering an area of nearly 4 square miles. The head at the power station varies between 312ft and 220ft.

There are two spillways on the left bank. Provided with Stoney sluices, their combined maximum capacity is 85,000 cusecs, the flow being discharged through two pressure conduits, each of 27ft 2¾in diameter. The reservoir may be drained by means of drain sluices built into the two diversion tunnels used during the erection of the dam.

The Sarrans Power Station

This power station is just downstream of the dam, which is provided with three 10ft diameter[1] pressure pipes. Each of these pipes supplies a vertical turbo-alternator set comprising a Francis turbine with a maximum output of 51,000 h.p., rotating at 214 r.p.m., and an alternator having an output varying between 7000kW and 39,000kW. Thus the total output of the works varies between 20,000kW and 116,000kW at a tension of 15kV.

The power stations of the district are generally provided with an auxiliary set to cover their own requirements for power and lighting. At Sarrans the auxiliary set is also

[1] Atlas Hydroélectrique de France, Chambre Syndicale des Forces Hydrauliques, &c., Notice No. 71.

of the vertical type. It is supplied from the three main conduits through a branch pipe, and supplies 1500 h.p. at 5·5kV. The alter-

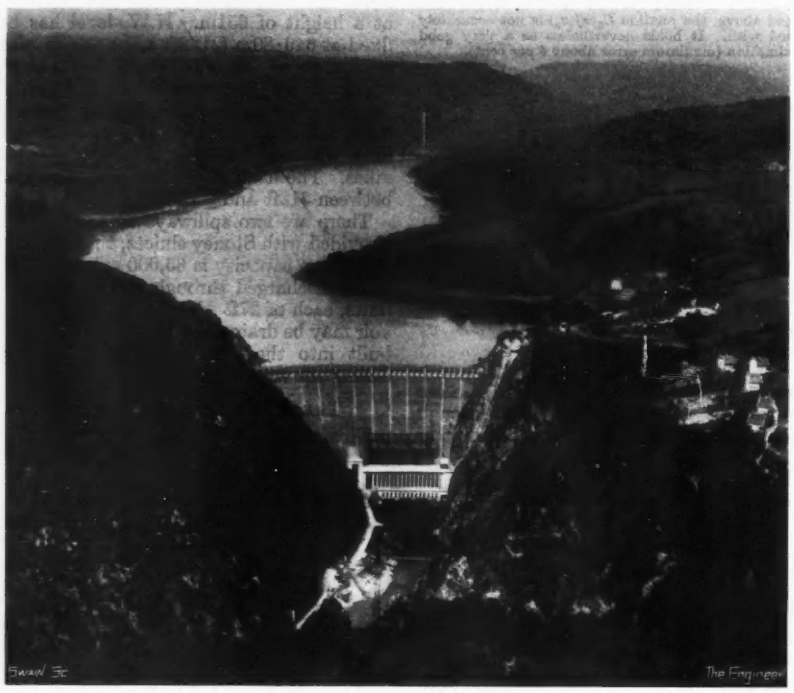


FIG. 8—SARRANS DAM

nator room is provided with twin overhead travelling cranes capable of a combined lift of 160 tonnes. The transformer station is of the open air type and is located within the free space between the foot of the dam and the upstream wall of the power station. A 15/220-kV transformer with an output of 40,000kVA is provided for each alternator. The energy produced is transmitted to the distribution station of Rueyres, some 6 miles distant, whence it is re-transmitted to Paris, Lyons, Saint Etienne and Roanne.

A short distance downstream from the

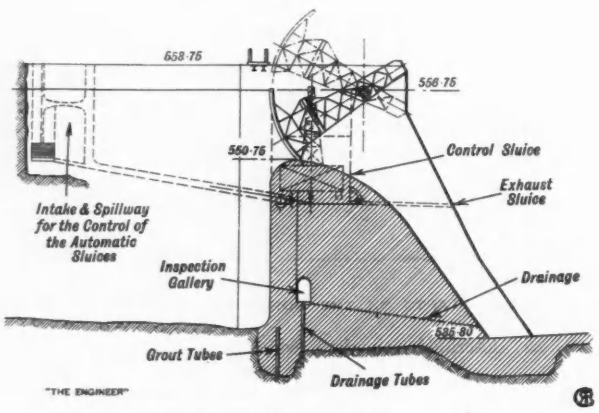


FIG. 9—LA CADENE WEIR

Sarrans power station, the waters of the Truyère are retained by the weir of La Cadène (Fig. 9); this weir is 45ft high and ensures a normal retaining level of 556·75m (1826·6 a.D.). It is provided with two automatic segment flood gates, 19·7ft high by 59ft. wide. A third sluice with 46ft by 13ft twin bodies is used for drainage.

On the right bank there is the intake to a tunnel leading to the downstream installations

1·8 miles long, leading direct to the vertical pressure shafts of the Brommat power station. Fig. 3 shows cross-sections of this tunnel with and without lining; the cross-sectional area is 36 square yards.

The waters of the Bromme are held up by an overflow dam of the arch type, having a height of 120ft. This dam is shown in plan and cross-sectional elevation in Figs. 11 and 12. The capacity of the reservoir available for power production is 200,000 cubic metres. This reservoir has a direct connection with the vertical pressure shafts at Brommat by

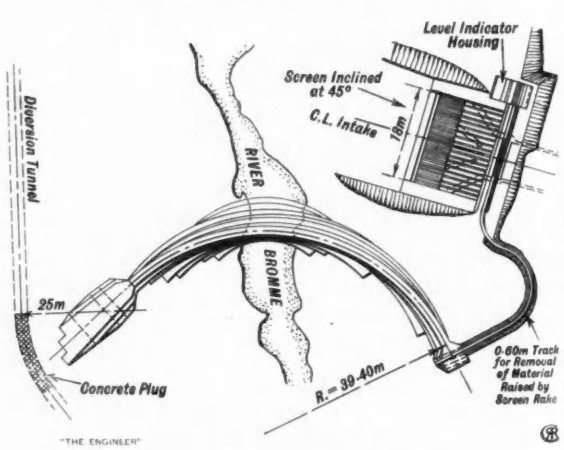


FIG. 12—PLAN OF LA BROMME DAM

means of a tunnel of 50 square yards cross-section, just over 1 mile in length (Fig. 4).

SHAFTS AND CONDUITS OF THE BROMMAT POWER STATION

Before this tunnel reaches the vertical pressure shafts it opens out into a compensating chamber *B* Fig. 13 and then divides into two branches. Each vertical shaft is provided with its own surge chamber. Both

are lined throughout with steel, so that they form conduits having a head of 858ft, the diameter reducing in size from 13ft $1\frac{7}{16}$in at the top to 8ft $6\frac{3}{8}$in/4ft $11\frac{1}{16}$in at the bottom,

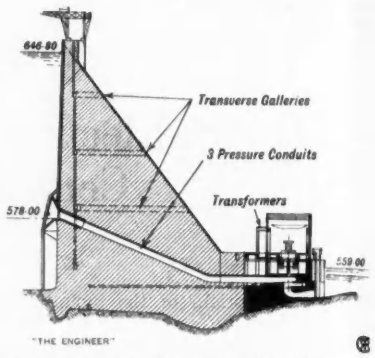


FIG. 10—SECTION THROUGH SARRANS DAM AND POWER STATION

while the thicknesses of steel rise from $\frac{1}{2}$in to $1\frac{3}{8}$in. At the bottom of the shafts two conduits lead off horizontally. Each of these two conduits supplies three turbines through

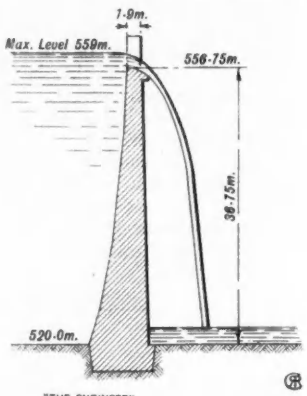


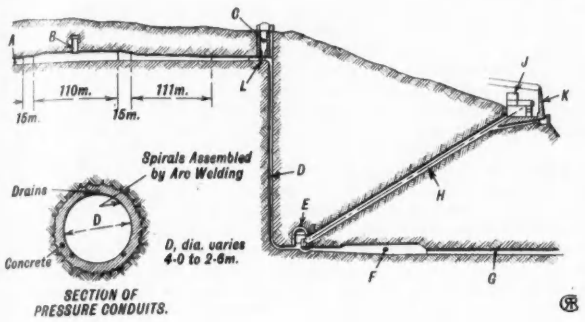
FIG. 11—CROSS SECTION OF LA BROMME DAM

individual connections which lead into an underground power station, which has been completely hewn out of the granite rock at a depth of 984ft. The approximate dimensions of the power station chamber[2] are: height, 95ft; width, 72ft; and length, 246ft.

The accompanying drawing, Fig. 5, shows the Brommat power station. The main turbo-alternator sets consist of vertical-shaft Francis turbines with an output of 38,200 to 41,650 h.p. under a net head of 787ft to 840ft and at 500 r.p.m. Mounted on the

[2] Atlas, &c., *loc. cit.*

shaft of each machine is an alternator with two exciters, with an output of 32,500kVA, giving a total maximum output for the whole station of 195,000kVA at 15kV. Three of the six turbines were supplied by Neyret-Beylier, of Grenoble, with alternators of Als-Thom manufacture. The three other sets were supplied as reparations after the 1914–1918 war by the firm of Voith, of Heidenheim (Germany) and St. Pölten (Austria), for the turbines, and by the Berlin A.E.G. for the alternators. In order to ensure uniform running of the whole plant, all six governors were supplied by Voith.



A Intake tunnel
B Compensating chamber
C Two surge shafts
D Pressure conduits
E Underground power house
F Expansion chamber
G Tail race
H Inclined access adit
J Brezou building
K Transformer Station
L Head sluices for pressure conduits

FIG. 13—BROMME SHAFTS AND POWER STATION

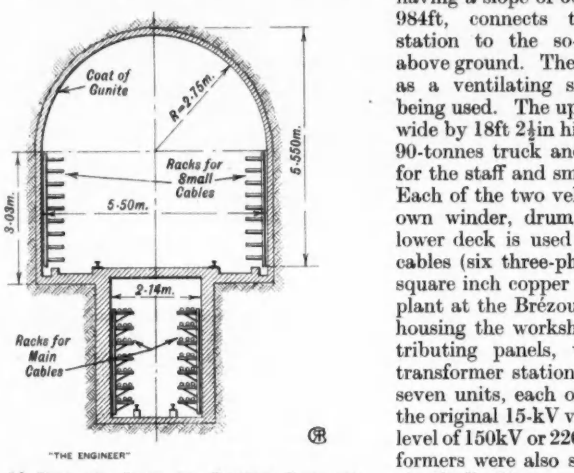


FIG. 14—SERVICE ADIT TO POWER STATION

The auxiliary set is also of German manufacture, and, exceptionally, is driven by a Pelton wheel with a horizontal shaft. The alternator room is equipped with two overhead travelling cranes, one of 15 and the other of 140 tonnes capacity, which are electrically interlocked in such a manner as to make any dangerous operation of both cranes at the same time impossible.

The underground location of the Brommat power station was dictated by the circumstance that an above-ground installation would have necessitated the extension of the tunnel from the Bromme reservoir across a very steep lateral gorge, on the one hand, and the drilling of a further gallery through a rock headland consisting of extremely hard and solid granite on the other hand. In addition, there is little, if any, space in the Truyère gorge for a power station of this size. The tail-race of the Brommat station is a tunnel of 39·4 square yards cross-section, underground over its entire length of 2870ft 9in, as far as its mouth at the confluence of the rivers Truyère and Bromme.

As shown in Fig. 14, a double-deck adit, having a slope of 60 per cent and a length of 984ft, connects the underground power station to the so-called "Brézou" plant above ground. The adit functions in addition as a ventilating shaft, no forced draught being used. The upper deck of this adit, 18ft wide by 18ft 2½in high, carries the track for a 90-tonnes truck and for a 5-tonnes lift cage for the staff and smaller items of equipment. Each of the two vehicles is provided with its own winder, drum and control gear. The lower deck is used as a duct for the 15-kV cables (six three-phase cables of 3 by 0·372 square inch copper for each alternator). The plant at the Brézou consists of the buildings housing the workshops, the control and distributing panels, various offices, and the transformer station. This station comprises seven units, each of 33,000kVA, which raise the original 15-kV voltage to the transmission level of 150kV or 220kV. Three of these transformers were also supplied as reparations by the Berlin Siemens Works and were the first in France to supply such high tension. The others were supplied by the Société Savoisienne de Constructions Electriques. Seven lines transmit the power to the distributing centre at Rueyres.

The Brommat plant was placed in service in 1932 and that at Sarrans started to operate in 1934. The hydro-electric development of the Truyère will be completed by the Couesque plant, now under construction further downstream.

(To be continued)

Armstrong Siddeley "Python" Gas Turbine Propeller Engine

ONE of the world's most powerful aero-engines, the Armstrong Siddeley "Python," has now been taken off the secret list by the Air Ministry. It is a gas turbine propeller engine, designed to develop over 4000 h.p. when driving 11ft diameter contra-rotating propellers, and the new single-engined Naval Strike fighter aircraft, the Westland "Wyvern," which first flew last March, and came off the secret list last week is fitted with this engine.

The "Python" is a compact engine constructed on the reverse flow principle. It first flew on January 3rd, when a specially converted Avro "Lancaster" aircraft was fitted up as a flying test bed with two "Python" engines in the outboard nacelles. Up to date the engine has completed over 6000 hours' development and test bed running.

In spite of the power of the new engine, the control is straightforward, a single lever enabling the pilot to control both the speed and the pitch of the propeller. The reverse thrust can be used as a landing brake, and a windmill brake is also incorporated so as to limit the speed of the aircraft when diving.

General Design

The general arrangement consists, in brief, of an axial flow compressor which draws air from a forward-facing air intake and compresses it into eleven combustion chambers radially disposed round the compressor casing. The turbine and compressor are coupled together on the same shaft. In order that 90 per cent of the total power output of the unit may be supplied to the propeller, the turbine is made larger than would be the case with a plain jet engine, to absorb more power from the gases. The gases are then expanded down to atmospheric pressure before being released in a comparatively low velocity jet at 500 m.p.h., instead of the 1200 m.p.h. of the pure jet. The "Python" is a reverse-flow engine—that is, the air entering the air intake is turned through 180 deg. and then moves forward through the compressor. After leaving the compressor the air is again turned through 180 deg. and passes rearwards. The overall length of the engine is therefore considerably less than it would be if a straight flow was utilised.

Dimensions

	Annular cowl installation
Maximum diameter over engine cowl, inches	54·5
Length, mounting flange to centre line of rear propeller, inches	85
Overall length, inches	156
Net dry weight, pounds	3150
Estimated installed weight (including propeller), pounds	4100
Compressor, fourteen-stage axial-flow, compression ratio	5 : 1
Turbine, two-stage	—

Performance (Sea Level)

	Rating		
	Max. take-off	Max. climb	Max. cont. cruise
R.p.m.	8000	7800	7600
Aircraft speed, m.p.h.	0	200	300
	0	300	400
Propeller shaft h.p.	3670	3450	3260
	3670	3800	3680
Net jet thrust, pounds	1150	660	390
	1150	490	220
Fuel consumption, gallons per hour	355	329	304
	355	342	321

The engine is mounted through eleven brackets on the back of the air intake casing, and all pipe, cable and control connections to the air frame are located at the rear of this casing. It can be provided complete with engine de-icing arrangements, and a supply of heat for aircraft de-icing purposes can be supplied under all conditions of flight.

The fuel used is "aviation kerosene" to Specification D.Eng.R.D. 2482, and the lubricating oil is to Specification D.Eng.R.D.2479.

Under sea level static conditions at 4000 r.p.m., the idling speed, the combined thrust of the propeller and jet is less than 200 lb.

Construction of Engine

General.—The engine, viewed from the side, as shown in the accompanying engravings, is made up of the following components. Starting at the front, we see the front cover, which carries the auxiliaries and also encloses the reduction gear and the two propeller shafts. Immediately behind the front cover is the diffuser casing and behind this the compressor casing. Surrounding the compressor casing are the eleven combustion chambers with the forward-facing air intakes leading to the compressor, which is situated slightly to the rear of them. The "SP1–1" engine has a circular intake and the "SP1–2" wing ducts on either side of the engine. The fourteen-stage compressor and the two-stage turbine are mounted on the same shaft, the turbine being located in a housing at the rear of the air intakes. Finally, the exhaust cone and propelling nozzle are fitted in that order at the rear of the engine.

Reduction Gear and Front Cover.—The reduction of speed required is from a shaft speed of

8000 r.p.m. down to two counter-rotating shafts running at 1080 r.p.m., a reduction of 0·135 to 1. The reduction is carried out in two stages; the first stage is a simple epicyclic gear, which reduces the speed to 2500 r.p.m. The sun gear is driven from the front of the compressor shaft via a torsion shaft and drives planet gears which mesh with a stationary annulus gear. The sun and planet gears are made of 3½ per cent nickel-chrome hardened steel, S82 forgings.

The stationary annulus gear is prevented from rotating by means of two link rods connected to two pistons. These pistons are nitrided steel stampings DTD 306 with cast iron piston rings and are automatically balanced by oil pressure and perform the function of torque-meters. The pressure of the oil in the piston cylinders is recorded on a gauge in the pilot's cockpit.

The planet gears are attached to a cage, which is an S11 forging, and at the front of the cage is a gear revolving at 2500 r.p.m., which completes the first stage. This gear drives four layshaft gears evenly spaced round it. Layshafts now transmit the drive from the four at 0·36 engine speed; and the scavenge oil filter.

A duct leads from the diffuser casing to a valve which, if opened, bleeds to atmosphere a certain percentage of the total quantity of air entering the compressor. This is to assist in starting; the valve otherwise remains closed. This valve also helps acceleration when starting by preventing the compressor blades from stalling.

The valve is coupled via a link rod to an oil-operated double-acting servo piston, which in turn is controlled from the cockpit by the pilot's throttle lever. The valve operates between 4000 and 5000 r.p.m.

The Compressor.—The compressor consists of a two-piece drum of aluminium RR 59, a forging, to which are attached at the front and rear high-tensile steel extension shafts. The front shaft is mounted on a double row thrust ball bearing, the rear shaft is mounted on a ball and roller bearing and is attached via a splined sleeve to the turbine disc.

The compressor and turbine are mounted on the same shaft and therefore rotate in the same direction and at the same speed, while the shaft turns in a clockwise direction when viewed from the cockpit. On the periphery of the drum are mounted fourteen rows of aerofoil section aluminium blades with a radial clearance (cold) of 0·050in. The blades are arranged in five rows of thirty-six low-pressure and nine rows of seventy high-pressure blades.

The whole assembly is enclosed in an aluminium casting which forms the compressor casing. This is made of RR 50. The casing is split on the horizontal line and contains the fixed RR 57 stator blades. The compressor blades revolve between fourteen rows of stator blades made of aluminium. The fourteen-stage axial-flow compressor has a compression ratio of 5 : 1 at normal revolutions per minute and can pass about 1¼ tons of air per minute. The rate of flow is about 500ft per second.

A drive is taken from the compressor front extension shaft to the propeller reduction gear and to the various accessories.

There is a thrust on the compressor of some 5½ tons. This is exerted rearwards in the opposite direction to that of the air flow and is taken by a double-row thrust ball bearing at the front of the compressor shaft. The front compressor bearing is oil cooled. The rear turbine ball and roller bearing is cooled by air fed from the fifth stage of the compressor which passes over the outer and under the inner races to atmosphere. A tapping is taken from the compressor to pressurise a chamber immediately in front of the rear bearing assembly so as to prevent leakage, and the transfer of air to the compressor intake.

In order to prevent leakage of hot gases from the turbine a pressurised labyrinth seal is fitted forward of the turbine disc, air being supplied from the compressor.

The Combustion System.—The diffuser casing is bolted to the end of the compressor casing. Attached to the periphery of the diffuser casing are the eleven diffuser elbows. The eleven combustion chambers of 22SWG light-gauge stainless steel are radially disposed round the compressor casing. They have been developed by Armstrong Siddeley Motors and differ from those used on other gas turbines, in that a vaporising principle is employed. The fuel is vaporised and mixed with heated air before entering the combustion zone.

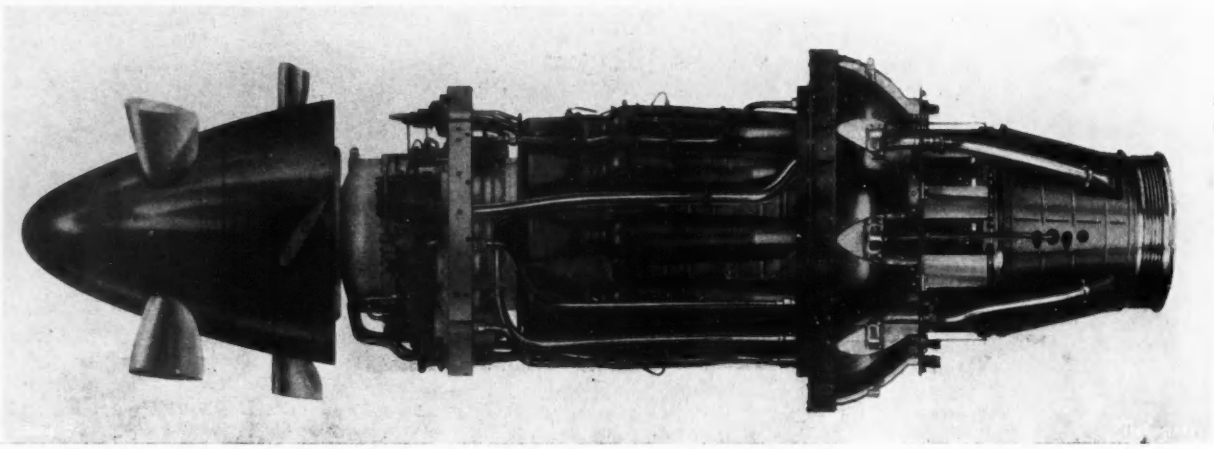
This arrangement gives many advantages over the more usual type in which the fuel is atomised, necessitating a high-pressure pump and other complications. For instance, vapour injection allows better control of flame than spray injection, where the distribution is dependent on a sensitive high-pressure atomiser, and the break-up of the fuel is dependent on fuel flow. Consequently combustion chambers utilising the vapour injection principle do not suffer from the marked deterioration at part throttle and altitude conditions associated with the spray injection type of combustion chamber. The combustion chamber itself consists of a hollow tube, inside which is the flame tube, which is made of 22SWG Nimonic 75. The combustion chambers and flame tubes are connected by balance pipes. This is to equalise pressure and enables starting to be carried out by means of two torch igniters. These are combined igniter plugs and paraffin jets fitted to chambers 2 and 7, numbered clockwise from the cockpit. No. 1 combustion chamber is situated at nine o'clock when the engine is viewed from the cockpit.

The forward-facing air intake is made up of an intake throat consisting of eleven radially disposed ducts leading into an annulus. The intake throat bolts on to the intake body, which has eleven radial inlet ducts coinciding with the eleven ducts on the intake throat. The intake body is bolted to the compressor casing.

The Turbine.—The turbine disc is a steel forging of special heat-resisting G18B steel with a radial clearance between the blades and casing of 0·075in cold, increasing to 0·105in when hot. The turbine blades are Mond nickel and Wiggins Nimonic 80, machined from the bar. The method of driving the turbine and the bearings in which it is carried have already been described when describing the compressor. Both faces of the turbine disc are cooled by air from the compressor.

Engine Controls.—The pilot's control consists of a single lever, which controls both the engine revolutions per minute and the pitch of the propeller.

In order to be able to accelerate the engine from no-power to full-power conditions in the shortest possible time the various controls have been interconnected to act in the manner described below. With the pilot's throttle fully closed the engine will idle at 4000 r.p.m. After the lever has been moved forward some distance the revolutions per minute will increase



PORT VIEW OF THE "PYTHON" GAS TURBINE PROPELLER ENGINE

layshaft gears forward to two driving gears on each shaft. The first driving gear meshes direct with an external gear on the rear end of the front propeller shaft, while the second driving gear meshes with an internal gear on the end of the rear propeller shaft, thus producing the necessary contra-rotation.

As seen from the cockpit, the front propeller revolves clockwise and the rear propeller anti-clockwise. A "Rotol" eight-blade contra-rotating propeller is fitted. So as to ensure even tooth loading on the four layshaft gears, the driven and driving parts of the layshafts are separately mounted on bearings and connected by means of torsion bars.

The epicyclic gears run on phosphor-bronze bushes. The layshafts are supported on ball and roller bearings. The thrust bearings for the front and rear propeller shafts consist of a duplex ball bearing and a roller bearing for each shaft. The engine auxiliaries are mounted on the auxiliary case cover and they all face forwards. The auxiliary case is integral with the reduction gear casing. The drive is taken to the auxiliaries by straight spur gears through idlers from two of the four reduction gear layshafts. On the starboard side the drives, starting at the top of the engine, consist of the electric tachometer, at 0·25 engine speed; the switch governor, at 0·7 engine speed; the "Rotol" constant-speed unit, at 0·35 engine speed; and the Lucas fuel pump and governor combined, at 0·38 engine speed.

On the port side, again starting at the top, the drives consist of the gas starter or turbo starter; the "Tecalemit" metering pump for rear main bearings, at 0·175 engine speed; the "Rotol" remote drive for remote drive box, at 0·36 engine speed; the oil pressure and scavenge pump and high-pressure oil pump for torque-meters and blow-off valve servo control,

to 6500, but the propeller will remain in fine pitch so that the combined propeller and jet thrust will still be less than 400 lb. As the throttle control is opened further, the pitch of the propeller blades and the engine revolutions per minute are gradually increased, resulting in a progressive increase in power from about 100 h.p. to 3670 h.p. at full throttle. This speed fuel relationship is maintained through the cam box. The hydraulic cam box translates movements of the pilot's throttle lever into variations of fuel supply co-ordinated with the constant-speed unit setting. A hydraulic servo-motor ensures that the propeller constant-speed unit control moves slightly later than the fuel lever. It is intended that, while taxi-ing or during flight, the engine speed should not be allowed to fall below 6500 r.p.m.

The Fuel System.—The "Python" fuel system consists essentially of a pump submerged in the tank, a low-pressure filter, an engine fuel pump, an isolator valve and a combined altitude and throttle control with a propeller contant-speed unit. The throttle control and constant-speed unit are linked together to a single pilot's lever. In addition, a distributor valve is provided and finally the burners each with four holes, are fitted in the combustion chambers. The fuel pump is a Lucas "C" type variable-stroke pump, incorporating an over-speed governor and maximum pressure relief valve. The maximum pump speed is 2800 r.p.m., giving a ratio of 0·36 to engine speed.

In the lubrication system a main pressure gear type pump draws oil from the tank and supplies it at 70 lb per square inch in the pressure being governed by relief valve. Oil is fed to the reduction gear bearings and jets, the constant-speed unit, the high-pressure pump and the blow-off valve servo piston. The high-pressure pump feeds oil at 350 lb per square inch (the pressure being governed by a relief valve) to the torque-meter cylinders.

A drive is provided for the aircraft accessories box, the rotational speed being 0·364 times engine speed with a capacity of 100 b.h.p. at maximum cruise revolutions per minute.

The following instruments are essential for satisfactory control and operation of the engine:—

Engine speed indicator	0–10,000 r.p.m.
Jet pipe temperature indicator ...	300–700 deg. Cent.
Oil inlet temperature indicator ...	0–120 deg. Cent.
Oil pressure gauge	0–110 lb per sq. in.
Fuel distributor pressure gauge ...	0–500 lb per sq. in.
Torque-meter pressure gauge	0–500 lb per sq. in.
Fire warning indicator	—

Operation and Starting

In operating the "Python" engine air is led in through a forward-facing air intake into the intake throat, consisting of eleven radially disposed ducts leading into an annulus at the entry to the compressor. After passing through the compressor the air, now at a temperature of 230 deg. Cent and pressure of 60 lb per square inch, is deflected radially outwards through 90 deg. by the diffuser casing guide vanes. The air is now divided into eleven air flows and is deflected on passing through the diffuser elbow guide vanes rearwards into the combustion chambers. Primary air, about one-fifth of the total mass, enters the flame tube from the compressor through a volute-shaped mixing chamber, which has a circular exit facing upstream.

Combustion takes place inside the primary zone. The hot gas passing back over the mixing chamber heats this and so vaporises the fuel, which is fed into it. Fuel is fed in at a pressure of approximately 14 lb per square inch above that in the chamber. Secondary air is added through the nose of the flame tube and is then deflected by a flat plate to the inside walls of the tube, so keeping the front portion of the tube cool and free of carbon. Further air is added by flutes on the nose of the flame tube. Holes in the flame tube, downstream from the mixing chamber, admit yet a further supply of air to the flame tube. Final mixing of the hot gas and secondary air is carried out by four shovel-shaped scoops attached to the outer casing about ⅜in downstream from the flame tube.

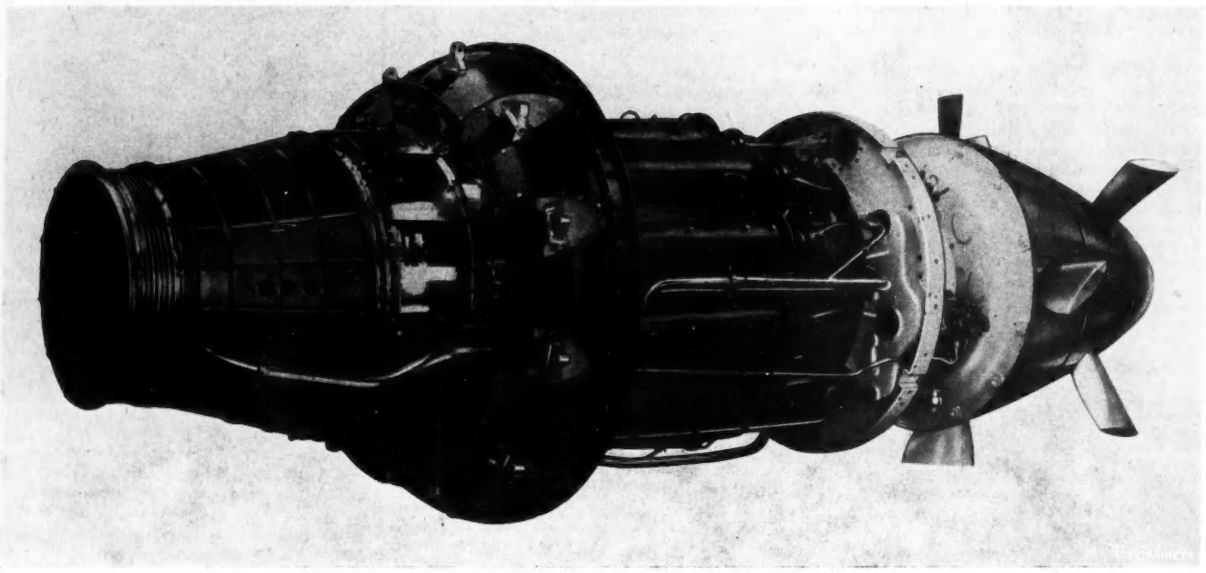
The mixture burns inside the flame tube at a strength by weight of about 15 : 1. The overall mixture strength—that is, the total weight of air inducted in relation to the fuel consumed—is about 65 : 1.

The eleven combustion chambers discharge the gases into eleven manifold pipes which pass between the air intake passages and are reformed into an annulus at the entry to the turbine. The gases flow now through the nozzles and blades of the two-stage turbine at a pressure on entry of approximately 57·5 lb per square inch, falling at the exit to ¼ lb below atmospheric pressure. The absolute gas velocity on the mean radius of the turbine disc at the first nozzle is 1890ft per second, and the axial velocity at the outlet into the exhaust cone 777ft per second.

The temperature at the first nozzles is approximately 827 deg. Cent. and at the exit cone 527 deg. Cent. The turbine blades are Inconel forgings. The turbine develops about 10,000 h.p.; 6300 h.p. is absorbed in driving the compressor, leaving a balance of 3700 h.p. After leaving the turbine the gases pass to atmosphere via the exhaust cone and propelling nozzle.

For starting purposes a gas starter mounted on the auxiliary case on the front cover rotates the compressor through the auxiliary drive and propeller shaft reduction gears up to 2600 r.p.m. The starter motor is gas operated and consists essentially of a revolving drum with sliding radial vanes mounted eccentrically in the bore of the outer casing. The starter develops about 35 h.p. and can be operated either by compressed air at about 140 lb per square inch or by a special cartridge. The consumption of air per start is about 11 lb and the weight of the cartridge is 18 lb, its dimension being 23½in in length and 4in in diameter. The exhaust gases from the starter motor are led into the main engine exhaust. The time interval elapsing between the instant of pressing the starting button and the engine reaching idling speed (4000 r.p.m.) is about thirty-five seconds.

Fuel is supplied from the fuel pump through special slow-running jets and this mixture is ignited by two torch igniters fed with current from a booster ignition coil. The blow-off valve is kept open for starting and closes automatically when the pilot opens his throttle lever. When the engine starts the torch igniters and the nine spray jets are isolated by the governor switch.



THREE-QUARTER VIEW OF THE "PYTHON"

Welded Pipe-Line in U.S.S.R.

Several pipe-lines of great length have been laid recently in U.S.S.R. for the conveyance of natural gas to Soviet cities. The longest is the pipe-line from Saratov to Moscow, a distance of 500 miles, of which 38 miles are under water. It consists of 70,000 pipes of 12¾in diameter, about 40ft long each. The overall weight of the pipe-line amounts to 50,000 tons, while the excavated earth represented a volume of some 7½ million cubic yards. The gas pressure welding process was used for the construction of this pipe-line; special precautions have been taken against freezing. In the Soviet capital the pipe-line is divided into two branches (West and East), ending at large batteries of gasholders. Another pipe-line for the conveyance of methane has been recently completed between Dachava (Carpathian Mountains) and Kiev, a distance of 385 miles. It consists of welded steel pipes of 20in diameter. Three types of pipes with thicknesses ranging from 6·3mm to 12·5mm were used. The city of Stalingrad has been provided with a natural gas pipe-line, 80 miles long, and another pipe-line has been laid between Bougourouslan and Kuybishev (100 miles). The production of natural gas in the U.S.S.R. is increasing and will amount in 1950 to some 11,000 million cubic yards.

Locomotives for Mewar State Railway

THREE 4–6–0 metre-gauge locomotives which have recently been completed by W. G. Bagnall, Ltd., of Stafford, for the Mewar State Railway have their coupling rod crankpins, connecting-rod big ends and eccentric rods fitted with Skefko self-aligning roller bearings. These locomotives, one of which is illustrated herewith, have the following leading dimensions :—

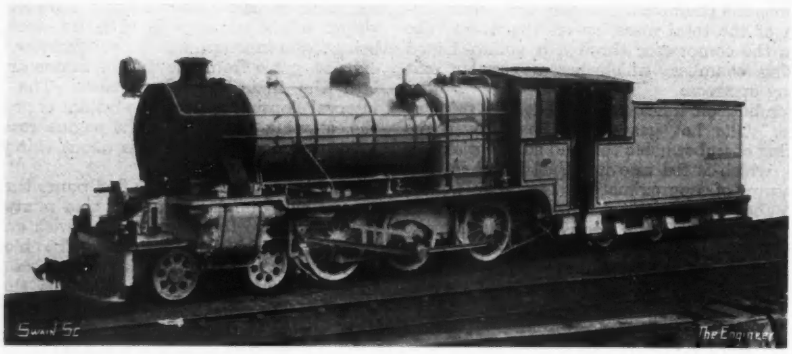
Diameter of cylinders ...	16¾in
Stroke of pistons	22in
Diameter of driving wheels	4ft
Diameter of leading wheels	2ft 4½in
Rigid wheelbase	11ft
Total wheelbase	20ft 2in
Heating surface of tubes ...	888 square feet
Heating surface of firebox	100 square feet
Heating surface of superheater	176 square feet
Total heating surface ...	1164 square feet
Grate area	25·5 square feet
Working pressure	180 lb per square inch
Bunker capacity	5 tons of coal
Tank	3000 gallons
Weight when empty (approx.)	50·5 tons
Weight in working order (approx.)	70·7 tons
Tractive effort at 85 per cent b.p.	19,674 lb
Ratio adhesion/tractive effort	3·4 to 1

The boiler barrel is 12ft long and has a firebox of the Belpaire type. The boiler casing is stayed by solid forged steel longitudinal stays, the top of the firebox by sling and direct stays and the inner and outside fireboxes are held together with copper stays of 1in diameter. The tubes, 113 in number, are of solid drawn steel of 1¾in outside diameter, swelled ⅛in in diameter at the smokebox end. A mild steel ashpan is secured to the foundation ring by studs and cotters and is provided with opening doors operated by levers on the footplate. Cast iron firebars are fitted to a rocking grate and the ashpan has bottom hopper doors. A double-valve cast iron regulator is fitted in the dome and operated by a rod connected to a handle on the boiler backplate. Two 2½in diameter safety valves of the Ross pop type are fitted on the firebox roof and are set to blow off at 180 lb per sarque inch. Two No. 7 m/m injectors with Simplex cones are fitted to take water at 125 deg. Fah. All steam valves are mounted on a steam stand with an isolating master valve and the boiler is fitted with a superheater header with fifteen elements.

The frames, of Siemens mild steel plates, are each rolled in one piece ⅞in thick and securely braced together by riveted cross-stays. The engine buffer beams are of cast iron, 4½in thick and secured to the frames by substantial angles and rivets. The forged connecting-rods have their large ends fitted with Skefko roller bearings and the forged coupling rods have roller bearings fitted at the driving end of leading rods, as shown in our illustration.

The tender tank, carried on six wheels, is built of mild steel plates and has a 3000-gallon water tank. The bunker on top of the tank has a capacity of 5 tons of coal.

Cast iron brake blocks are provided on all coupled wheels and all tender wheels. Brakes are applied by a steam valve combined with a vacuum ejector, which can be operated together or separately—the vacuum brake on the train and tender, and the steam brake on the engine.

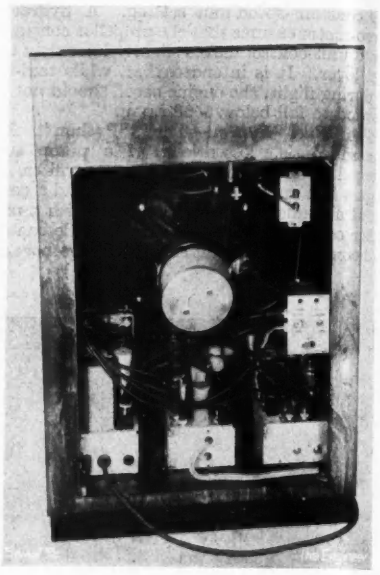


METRE-GAUGE LOCOMOTIVE FOR MEWAR STATE RAILWAY

Magnetic Tape Recorder

THE new magnetic tape recorder made by the General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, has been designed as a high-fidelity speech and music recorder suitable for educational purposes, recording scientific lectures, medical use (speech therapy, psychiatry), police and railway use, orchestral and theatrical rehearsals and the recording of radio programmes.

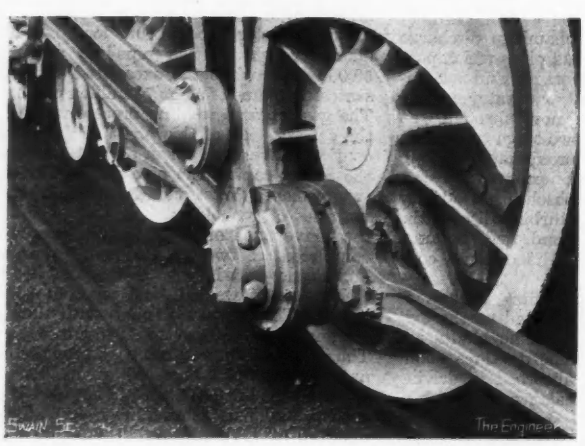
Recordings can be made from a microphone, radio receiver or telephone line and can be stored or replayed indefinitely without deterioration. When no longer required, recordings can be erased magnetically and new recordings made on the same length of tape, which is made of plastic and coated with magnetic iron oxide. A characteristic of the tape, which is of standard dimensions, is its strength and the ease with which it may be cut for editing purposes and rejoined with ordinary adhesive plastic tape. Additional spools of tape can be purchased as required. The recorders now in production have 1000 yards of tape, giving a running time of eighty minutes high fidelity recording, the tape speed being 7½in per second. Coloured paper tape can be attached to the magnetic tape, at intervals, to act as a visible marker or alternatively metallised tape may be used in conjunction with the recorder mechanism, to act as an automatic selector or stop.



REAR VIEW OF RECORDER

The equipment is very simple to operate and has four push-button controls marked "Play and Record," "Fast Forward," "Rewind" and "Off," which are mounted on the top panel, illustrated herewith. An independent lever has to be operated at the same time as the "Play and Record" button for recording, with the object of preventing the accidental erasure of a programme which might otherwise occur, since erasure is automatic when a new recording is being made.

As shown in the accompanying close-up



COUPLING-ROD DRIVING CRANK PIN

TOP PANEL OF RECORDER

view of the top panel there are three separate heads, which are used for erasing, recording and reproducing. The use of a separate replaying head and amplifier permits continuous monitoring of the signals actually recorded, and gives a complete functional check of all parts of the equipment and the adjustment of correct sound level. Neither the check nor the adjustment would be possible if the monitoring merely consisted of reproducing a fraction of the input signal. The recording and reproducing heads are each fitted with adjusting screws to permit exact alignment for maximum treble response, either with each other or with recordings made on other machines. When replaying, the tape runs clear of the erasing and recording heads to minimise the wear on them.

Reproduction is by means of a built-in 12in loudspeaker, and special amplifiers are used in the recorder with audio frequency response characteristics which are complimentary to the response of the recording system, thereby securing a remarkably high degree of fidelity. A rear view of the recorder, reproduced herewith, shows the loudspeaker, power pack (bottom left), recording amplifier (bottom centre) and reproducing amplifier (bottom right).

The characteristics of the recorder are tabulated below :—

Overall audio frequency response (record to reproduce)...	Flat, with 4 db for the frequency range 40–8000 c/s
Total noise and hum level	Better than 48 db
Rewind time and fast forward winding time ...	2½ minutes for 1000 yards
Short-term speed variation	± 0·1 per cent
Inputs, high-impedance (radio), single-sided ...	0·5V into 1 megohm
Inputs, low-impedance (microphone), balanced	15 ohms for moving coil microphone
Audio output	4W into built-in 12in loudspeaker or external loudspeaker
Voltage output	4V (average) into 50,000 ohms—1 megohm
Recording or replaying time	1 hour 20 minutes per 1000 yard reel
Tape speed...	7½in per second
Power supply	200–250V, 50 c/s
Power consumption	200VA

The F.B.I. and the Economic Crisis

THE Federation of British Industries has this week issued a statement which expresses concern over the inadequate appreciation of the country's economic situation. There is now grave danger, the F.B.I. says, of being unable to obtain the food and raw materials that are needed, and soon further austerity and unemployment will have to be faced unless some solution of our difficulties is found. The full text of the statement is as follows :—

"*The Dollar Shortage.*—In the first place, we share with many other countries in a shortage of dollars to buy from America and Canada the goods which only they can immediately supply. Marshall Aid has been designed to fill temporarily the gap between these imports and the European and other exports which directly and indirectly go to pay for them, and it was hoped that by 1952 we should be self-supporting. It has become clear that our reserves are being spent far too rapidly. Great Britain is the banker for the whole sterling area, with the advantages and the responsibilities that this fact involves. Our reserves are now reduced to 20 per cent below the lowest margin of safety. Palliative stop-gap measures are being imposed by the various Governments concerned, pending the conference at Washington in September. Nobody, however, suggests that these measures provide a permanent solution.

"*Balance of Payments.*—Great Britain is particularly vulnerable, as we have to import 60 per cent of our food and a great deal of our raw material. We are therefore faced with the second problem—that of paying our way, with temporary help in dollar markets—in our international trading with all other countries (including dollar countries). In 1948 we achieved this balance, but only under abnormally favourable conditions. It is doubtful if we are doing so to-day. Moreover, a large part of the credit side of the balance consisted of exports made in payment of wartime debts, and therefore not available to buy the imports we currently needed. To that extent the balance was unreal. The payment for current imports must come from yet more exports sold under normal competitive conditions. Irrespective of the dollar gap we must put ourselves in a sound trading position with the rest of the world. It is our visible exports from productive industry, together with the invisible exports arising from the whole machinery of trade, including the services rendered by shipping, industry, banking and insurance, that must pay for the imports of food and raw materials, and there can be no escape from the hard logic that our standards of living, including social services, must be cut according to the cloth we can from now on make.

"*Great Britain's Domestic Policy.*—We are still living beyond our means. The vast and menacing increase in State expenditure constitutes the basic inflationary influence in our whole economy. It is this which bears most heavily upon production costs and is one of the most serious handicaps to the future of British trade and to the living standards and employment of our people. Now that we have passed from the seller's market of recent years, the dangers of living beyond our means, with its corollary of high and crippling taxation, will be felt. The re-establishment of Western civilisation must come from the co-operation of many nations on both sides of the Atlantic. Great Britain as a world power has a special responsibility to play its part. Unless she earns it, she has no right to expect a higher standard of living than her neighbours. Unless she earns it she will not long maintain the standard that she now enjoys. This is emphasised by the evidence that is now accumulating that in fact she is believed by other countries to be attempting to achieve too quickly what she can no longer afford. The savings of past generations have been spent in the war. Future prosperity depends on present effort.

"One thing is obvious : we must as a nation pay our way. This depends on productive industry, supported by the trading and other services that earn our invisible exports. There is therefore the plainest necessity to give every encouragement to it. In the competitive conditions that are increasingly to be expected it is essential that every help be given in reducing costs of our exports ; value for money alone will enable us to sell in overseas markets. This means that taxation and, therefore, Government expenditure must come down. At present the tax-gatherer collects 8s. out of every £ that the nation produces. Profits are taxed even more heavily than this, and no opportunity is left to create adequate reserves. It is little wonder if companies—or individuals—feel little inducement to take the risks which the situation demands. The high taxation which we now bear is itself a direct cause of high costs. It means, too, that the rigidity of the planning of our economic life should be relaxed. Controls have undoubtedly been reduced in number, but more could be abandoned. Price mechanism will, as it has in the past, apply the necessary correctives. The spur of competition is still the most effective aid to efficiency. Furthermore, it means that we must face the fact that as a nation we must work harder without increasing costs of production. It also means that we must concentrate on the things that matter. Such schemes as the nationalisation of iron and steel are irrelevant to our present crisis, distracting to those who should be concentrating on production and marketing problems, and damaging to our future prospects. As to production efficiency, every one engaged in industry must strain every nerve to cheapen methods of production, to abandon restrictive practices, and to adopt all possible aids to increased productivity.

"The programme is one that will demand effort and sacrifice from all. It will not of itself solve our difficulties, but without it no solution can be found. Unless we are prepared as a nation to take such measures as are within our own control we shall not create the confidence in our sincerity that must be the foundation on which international action can be built. These same measures will also help us to bring down the costs of our exports, to hasten the day when we are once again self-supporting, and to enable us by our own efforts to bring back prosperity."

Transformers for 275kV Transmission

AT the recent British Electrical Power Convention at Torquay, the Chief Engineer to the British Electricity Authority, Mr. V. A. Pask, announced that orders had been placed for transmission line and transformers for an experimental section of a system that would reinforce the existing 132-kV grid. The nominal operating pressure will be 275kV, and we learn that the transformers will be three-phase units of 120MVA capacity, auto-connected for a voltage ratio of 275/132kV with no tappings. In spite of their large size they will be capable of transport from works to site with no more than the usual amount of dismantling. Two transformers have been ordered, one from the British Thomson-Houston Company, Ltd., for installation at the Staythorpe power station, near Newark, the other from the English Electric Company, Ltd., for installation at West Melton, near Sheffield. This scheme marks a further stage in the development of the transmission of electricity in Great Britain, and it is interesting to record that since the initiation of the grid in 1928 some 12 million kVA of 132-kV transformers have been supplied by British makers. It is also significant that British manufacturers have built, or have in course of manufacture, transformers totalling about 1¾ million kVA for service at 220kV or higher voltages.

Electricity Load Spreading

THE Electricity Sub-Committee of the London and South-Eastern Regional Board has carefully examined the problem of load spreading in its region for the coming winter, 1949–1950, and has decided that the following contribution to the spreading of the electricity load must be secured. In November, between the hours of 4 p.m. to 5.30 p.m., 90 per cent of the 1946–47 peak load will be allowed ; in December and in January, from 8 a.m. to 10 a.m., the percentage allowed will be 80 per cent, and from 10 a.m. to 12 noon 90 per cent., returning to 80 per cent between 4 p.m. and 5.30 p.m.; in February, between 8 a.m. and 10 a.m., the percentage allowed will be 80 per cent and 90 per cent between 10 a.m. and 12 noon. A decision regarding the evening hours in February, and both the morning and the evening hours in March, will be reached during January and will be conveyed to consumers in time for any necessary action. The region as a whole must achieve such a reduction as will ensure the maximum loads shown by the percentage figures. It will therefore be necessary to ensure that the total load for the industrial and the larger commercial consumers of 10kW and over in the area does not exceed the percentages shown. The Regional Boards and District Committees will only be actively concerned with commercial users of 10kW and over. The machinery which has been previously employed has been kept in being and will be used again for the winter of 1949–50 as follows :—At regional level, the Electricity Sub-Committee of the Regional Board for Industry, including departmental representatives and in collaboration with the representatives of the Area Boards of the B.E.A., will consider general problems and difficulties, watch progress and see that the full regional target is achieved. At district level, the District Advisory Committees of the Regional Board, with local representatives of the Electricity Boards, will co-ordinate the work of the local committees.

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts: correspondents are therefore requested to keep copies.

For Subscription Rates, see page 2 of Advertisements.

DEATH

On August 16th, at Seamer Lodge, Langham Road, Teddington, GEORGE STEPHEN BAKER, O.B.E., D.Sc., late R.C.N.C., first Superintendent of the William Froude Laboratory.

COAL-TO-OIL CONVERSION ON THE RAILWAYS

DURING the summer of 1946, it will be remembered, there was much concern about coal supplies. The demand for coal was growing as this country's industries re-converted their plants to peacetime uses. But the output of the mines was low and showed little improvement as the months passed by. Even by midsummer it was possible to estimate from the fact that stocks, normally high at that period, were dangerously small that the expansion of industrial output might be delayed by coal shortage during the winter. The fuel crisis of February, 1947, was, indeed, already throwing its shadow before it. It was under these circumstances that the Ministry of Transport hastily decided to authorise the main line railway companies to proceed upon the conversion of 1217 locomotives to oil firing. It was hoped thereby, when the conversion was complete, to save about 20,000 tons of coal per week (or about 1 million tons per year), and it was believed, upon what foundation it is now difficult to discover, that the 840,000 tons per year of oil which would be required could quite easily be made available. At the same time, various other industries were being encouraged to convert fuel-burning appliances to oil firing. The eventual saving of coal on the railways at a rate of 1 million tons a year was thus only a part of a general drive towards coal saving by conversion. Almost exactly a year later, when it became clear that it would be difficult to obtain the necessary supplies of oil and at a time when ninety-three locomotives had already been converted to oil firing, the programme was stopped. Expenditure amounting to £1,335,309 upon this scheme had by then been incurred, and it is estimated eventually to reach £3,000,000.

This expenditure is criticised in the Third Report of the Committee of Public Accounts, issued last week. The Committee recognises "that it may sometimes be necessary to incur expenditure in order to meet expected contingencies and that such expenditure is not necessarily nugatory if the expectation is falsified by events." But, very properly, and quite severely, it goes on to remark, "extra time spent, before embarking on such schemes in ascertaining all the facts necessary for judging whether proposals are likely to serve the purposes intended may not only save unprofitable expenditure, but also lead to the adoption of more practical measures." It seems to us probable that the Ministry of Transport was led into the hasty action thus criticised not only by advices that enough oil would be available, but also by a technical success obtained by the Great Western Railway. That railway, following upon exhortations by Government spokesmen to industry in general to find means of economising coal, set about converting eighteen heavy freight locomotives to oil firing in the autumn of 1945. The performance of these converted locomotives was found, once drivers and firemen became accustomed to them, at least equal to that of coal-burning engines. The experiment also provided some definite consumption figures. On average the locomotives burned some 6 gallons of heavy fuel oil per mile as compared with 75 lb of coal per mile in similar service. By mid-1946 the Great Western had decided to push the experiment further. A "Hall" class locomotive was converted and the announcement made that twenty-five "Castle" class engines would be converted. Thus, technically, there was little doubt at that time that engines of at least all the heavier classes could perform satisfactorily with oil as a fuel. Little, however, can have been known about running costs. That knowledge was gained later. In the report of the Comptroller and Auditor General on Civil Appropriation Accounts, 1947–48, issued in May of this year, it was noted that by November, 1948, expenditure had reached nearly £3,000,000. For the conversion, necessarily, included the provision of expensive oil storage depots. It was shown also that though the conversion scheme was ended in September, 1947, work upon the construction of those depots continued and that even at the beginning of 1948 the Ministry was still unwilling wholly to abandon the scheme. But the newly formed British Transport Commission did not take long to make up its mind. The additional cost of working the ninety-three locomotives by then converted had proved to be £279,000 a year. If over 1200 had been converted it would have been £3,500,000 a year. In May, 1948, the Commission decided to re-convert the locomotives to coal firing. But the Ministry is still maintaining the storage depots. Their future is due for review in October this year.

It is a sorry story. It is all the sorrier in that it gives some revelation of losses some other industries may have incurred through patriotically following the exhortations of the Government and believing its promises that adequate supplies of oil fuel would be forthcoming. How many coal-burning appliances in industry, we wonder, were converted in 1946 and 1947 to oil firing and have since, at considerable expense and trouble, been re-converted? How does the loss compare with that incurred upon the railways? Moreover, is there not a moral to be drawn? Here is an example of a central body, the Ministry of Transport, acting hurriedly without awaiting data upon which alone its decision could be firmly founded. In opposing the Ministry the British Transport Commission acted sensibly. But dare we assume that it or the National Coal Board or any other such great body will not, like the Ministry, at some time act hastily in an emergency and similarly involve the country, for very little gain, in an expenditure of several millions? At a cost of some £3,000,000 the Ministry and the railways have gained experience of oil firing of locomotives. Had the Ministry been less hasty that very interesting lesson would still have been learnt. But it would have been learnt at a cost absolutely far less to the country and relatively much less even to the G.W.R. Moreover, that very much smaller cost would have been adequately justified, as the larger cost is not, by the growth of technical experience and the proof that a technically feasible conversion was economically unsound.

AMERICAN AND BRITISH PRODUCTIVE METHODS

THERE are more ways than the direct one of conveying a sense of disparagement. If Uncle Bob pays a call on his brother with whose wife and family he is well acquainted and spends much time extolling the virtues of his young nephew William, while neglecting even to mention his other young nephew, George, an observer will draw his own conclusions about the latter's character. And what is poor George to think, particularly if he knows very well that, in fact, his performances compare very well with those of William? For he has no hope of redress. Certainly he has been very effectively disparaged. But he cannot claim to have been damned either outright or with faint praise. Nor can he gain much by expostulating. For his uncle can blandly reply, "But what is this about, dear boy? I have said nothing against you." It is all very aggravating for George, and he earns our fullest sympathy. For we feel ourselves to be in just George's position. In a broadcast talk last Thursday, Professor Matthew had much praise for the

virtues of the American technical press. We cannot recall that he said anything in criticism of the British technical press. But, then, we do not think he said anything at all about it! We are driven to assume either that his opinion of it was low, or, alternatively, and we hope rightly (for we do not believe that the British technical press is one whit inferior to the American and, indeed, have a higher opinion of its performance), that he really did not know very much about it. Uncle Bob can be excused for extolling only nephew William's virtues if his acquaintance with George is merely of the nodding variety!

But even if Professor Matthew has a better acquaintance with the British technical press than his broadcast in the "Questions of the Hour" programme seemed to suggest we will forgive him. For in extolling American industrial methods as he did over a very wide field, he was only doing what numbers of Government spokesmen, representatives of management and even many British engineers have been doing this very many months past. Nor was he alone in extending implicit disparagement of British methods to the British technical press. For in its report on its Second Session the Anglo-American Council on Productivity, apparently overimpressed by an exhibit of American journals that it had seen, did very much the same thing. No doubt it is because the Government is eager to see the rate of production in this country raised so that our oversea accounts can balance and the standard of living rise that it is emphasising so much the virtues of American methods, and encouraging others to look to America as to a schoolmaster. But have these American methods no disadvantages, too? Is it really true that they are applicable in this country? Many American factories are, indeed, very impressive places. But, we think, those who are for ever extolling the virtues of American practice should cultivate a more critical attitude towards them. By all means let us extend standardisation in this country; by all means let us mass produce. But it is first necessary to determine whether the economies so achieved at heavy capital cost in highly productive plant will so lower the price of the articles produced that the consequent demand will be sufficient to absorb the greater output. An American firm manufactures predominantly for a large self-sufficient home market. But Britain has to manufacture for the world. It is not usually possible both to manufacture a standardised article and at the same time to vary goods to suit the preferences of the many markets in which they are to be sold. The markets for British and American goods are very different.

For ourselves we sympathise strongly with the correspondent who finishes a letter to the Editor, which we print on another page this week, with the words, "British engineering is quite competent to stand upon its own feet, and those who are for ever urging it to lean upon America do it a grave disservice." Britain must solve its own problems of production to accord not with American ideas which are suited only to the American market, but with the hard facts of customer preferences all over the world. In some industries and for some types of product the expenditure of capital upon more highly productive plant is fully justified, and in our experience the British firms concerned are not only already well aware of it, but are getting on with its installation. In others, marketing conditions justify no more than those minor improvements of processes and methods that are constantly going on, as much in this country as in America. Over wide fields the possibilities of standardisation are being critically examined by the B.S.I., trade associations and even by individual firms. But how far it can be carried is a British problem. For the degree to which it has already been carried in America has in reality little relevance in Britain. British manufacturers, in fact, need to work out their own methods of production to suit their own marketing conditions and the circumstances of the time. There is, we believe, plenty of evidence that that is precisely what they, helped by engineering societies and such bodies as the British Institute of Management, are very actively doing. But there is, of course, no reason why American methods should not be studied provided they are studied critically to relate them to British conditions. Nor do we see anything undesirable, as our correspondent does, in sending students across the Atlantic to study production methods. Extension of experience is always valuable. But constant uncritical adulation of American methods that are often unsuited to British conditions serves only to hide the very real advances that are being made in this country and to convince the world, quite erroneously, that Britain is technically and productively backward. Thereby, we believe, much harm is done and Britain's economic recovery appreciably hindered.

Obituary

RICHARD WATNEY

MANY of our readers both in Great Britain and in Australia will learn with regret of the death on Monday, August 8th, in Melbourne, Australia, of Mr. Richard Watney, a director of Rootes, Ltd., following a motor accident. Mr. Watney was throughout practically the whole of his career engaged in the British motor-car industry, chiefly with the Rootes Group of companies. Before his appointment as retail sales manager of Rootes, Ltd., in 1930, he was the sales manager of Warwick Wright, Ltd., a firm which has since been absorbed into the Rootes Group. In 1935, Mr. Watney was appointed the managing director of Lagonda, Ltd., of Staines. He was a recognised authority on production methods, and at Lagonda's, Staines, he organised during the war one of the largest Ministry of Supply gun-production groups in the United Kingdom. In addition, he was responsible for shell-filling plants, which produced some 50,000 25 lb shells per day. Another of his activities was the development and production of the "Crocodile" and "Wasp" flame-throwing equipment, used on armoured fighting vehicles.

In 1946 Mr. Watney was appointed the general manager of the Rootes Group plant in Australia. Under his able direction the factory was developed and expanded to a degree which made it one of the major plants in Australia.

His death following a motor accident will be a severe loss to the firm he has served so well, and to his many friends in this country and overseas.

A Soil Stabilisation Process

LAST week, we were able to take advantage of an opportunity provided by the A.S.P. Chemical Company, Ltd., of Bulstrode, Gerrards Cross, Bucks, to see a demonstration of the making of a road by a new soil stabilisation process. The A.S.P. Chemical Company, Ltd., is a research organisation, set up principally with the object of developing new uses for sisal, a plant grown in Kenya, Mozambique, Nyasaland, Angola and other parts of Africa, and also in Java, Haiti, Brazil and elsewhere. Sisal fibre, to date, has been used mainly for binder twine, and its price has fluctuated so widely that even well-managed estates have sometimes been hard put to it to make ends meet. At present the recoverable fibre and tow on which the sisal plant industry is based represents only about 3 per cent of the leaf. The company has found means for obtaining a number of valuable products out of the remainder of the material.

But few of these uses are directly of interest to engineers. One of them, however, the subject of the demonstration we went to see, should interest road engineers in this country and more especially in less well-developed countries overseas. For it offers a means of forming roads cheaply from existing soils of a widely varied character.

The system of stabilising soil in order to provide an all-weather bearing surface is now well known. Its aim, of course, is to fix the moisture content of a treated soil at just that amount which will prevent the material becoming soft or muddy on the one hand, or, dusty and crumbly on the other, thus preserving it in a state that gives it its highest load-bearing capacity. Various methods have already been used to attain this desired result, The soil stabilisation investigations at Bulstrode. pursued in co-operation with the Road Research Laboratory of the D.S.I.R., have, it is claimed, shown that sisal waste, ground and treated, can be used as an efficient soil stabiliser. Groundnut husks, palm-kernel husks and certain other waste materials have also been found to be equally effective. Working upon these lines, a vegetable waste stabilising material named Pectosol has been produced by the A.S.P. Chemical Company, Ltd. Mixed with cement in equal proportions (the cement acting as a chemical and not as a binder), Pectosol is claimed actually to increase the load-bearing strength of natural soils.

At the demonstration last week a small area of soil was treated near the entrance drive to Bulstrode House. The whole process is very simple. Just before work is started samples of the soil to be treated are tested to learn what moisture content gives the maximum load-bearing strength, and other samples give a measure of the actual water content present. From these figures it is simple to calculate how much water must be added during the process. The first operation consists of tilling the soil with such an implement as a rotary hoe to a depth of, say, 6in until it is well broken up. About 3 per cent by weight of Pectosol-cement mixture is then added and thoroughly mixed in with the rotary hoe. Next the required quantity of water is added and finally the soil is rolled. As soon as possible after rolling the surface is sealed with a fluid bitumen or tar emulsion, at the rate of 1 gallon to 7 or 8 square yards. A carpet of gravel or rough ballast is then laid, rolled and again sealed. It is estimated that the cost in Great Britain of building a road by these means would work out at about 3s. per square yard. The soil treated at the demonstration was overburden from a local sand pit. We were informed that clay, chalk, laterite (the East African ground nut scheme has this soil to contend with) and brick earth have all been satisfactorily treated in the laboratory.

So far expectations based upon this new process rest on the results of laboratory tests. Obviously only prolonged field trials can show how well roads formed in this way will withstand severe climatic conditions. Arrangements have been made to have such trials conducted. The Overseas Food Corporation intends to lay several miles of Pectosol-cement

roads in East Africa, and the United Africa Company, we learn, is also to construct an experimental section near Lagos, in Nigeria. The Public Works Department of Kenya also proposes to test the process.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

BRITAIN AND AMERICA

SIR,—I have read with some concern (THE ENGINEER, page 149, August 5th) that fifty British students are to be sent to America to study methods of production. This action is on a par with a trend, all too common, to look to our Western cousins as our schoolmasters and to weaken still further the confidence in our own abilities that made industrial Britain what it was and what it still has the power to be. I have seen no indication that other European nations of technological eminence have subjected themselves to this adulation of American methods. They have advanced by the study of their own problems, by their own genius and—witness Switzerland, Norway and Czechoslovakia—have developed methods that are second to none for the conditions of the country.

We can, I fervently believe, do the same for ourselves and win back, at the same time, the self-confidence and self-reliance which in industry, as in sport, is more than half the game.

It is an error to suppose that more science enters into American engineering than into European or British. Unless American technical and scientific education has changed since the late thirties it is still a good deal lower, taken by and large, than British education, and the oft-quoted statement that a much larger proportion of university men is employed in American factories than in British means little or nothing. I venture to say that it has no more than a trifling effect on American technological and business methods.

American methods are the natural outcome of the national conditions. They suit America just as Cotswold stone suits Cotswold country. To lift them into another atmosphere, to transplant them into a different kind of soil may not have the desired result. When the Ford Company came to Dagenham it found that it had to acclimatise itself to British conditions. It very rightly and wisely made itself—not an American factory in Britain, but a British factory, with British methods and British ways of thought. That has happened over and over again in our industrial history. Too much cannot be said in its favour just as long as the industries that grow up develop their own independence. When, however, as too often happens, foreign firms seek to dominate their British offshoots, we become subjects to foreign influence and our national morale is adversely affected.

By all means let us keep our minds open to American methods, but at the same time let us jealously guard our own engineering genius and refuse utterly to become copyists. Our salvation lies in ourselves. British engineering is quite competent to stand upon its own feet, and those who are for ever urging it to lean upon America do it a grave disservice. L.P.

August 15th.

HIGH-TEMPERATURE BOILER FEED PUMPS

SIR,—The article entitled "A Compensated Boiler Feed Pump," in your issue of July 29, 1949, implies that the adoption of the most economical thermal cycle has been handicapped by the lack of suitable feed heaters and feed pumps and that the introduction of a new pump has solved the problem. The impression conveyed is misleading and I hope you will hasten to correct it in the interests of equity and historical accuracy.

High-temperature boiler feed pumps have been in successful operation for many years, and as long ago as 1927 some large feed pumps were designed to take their supply direct from the final stage heaters at about 400 deg. Fah. These pioneer pumps ran successfully from the day they were started up and they are still in regular service, operating for 40,000 working hours between routine overhauls. Although not specifically designed for sudden temperature falls over a very wide range, yet they have stood up to the arduous working conditions for over twenty years, and the fact that pumps of similar construction have been ordered for the recent extensions speaks for itself. Later pumps, of which a large number is in service, permit the feed temperature to be reduced suddenly from the maximum designed figure to any lower temperature. This has been demonstrated frequently on the test-bed, but practical experience is the more convincing argument, and where this make and type of pump is installed it has been proved repeatedly during the last fifteen years that the whole range of heaters can be by-passed simultaneously without detriment to the pumps.

Experience in the use of pumps of the vertically split sectional-casing type has shown that there is no need to introduce the more complicated and expensive barrel construction to meet any of the pressures and temperatures likely to be encountered in boiler feeding. Moreover, the opinion has been expressed that it is preferable to have the interstage joints exposed with the comforting knowledge that they are tight rather than have the pump encased in the barrel, thus risking serious erosion and loss of capacity (owing to interstage leakage) before the trouble is detected. This is a grave problem with barrel type pumps as, apart from high maintenance expense, frequency of repairs sometimes reduces availability seriously.

R. PENNINGTON,
Director,
MATHER AND PLATT, LTD.

Manchester, 10, August 12th.

HELICAL GEARS CUT ON "SOLID TABLE" MACHINES

SIR,—In part III of this article, Mr. Couling refers to the difficulty of "production of matching (helix) angles on an engaging pair of gears." Expressed in this way the problem appears unnecessarily difficult. It is fortunately not one of matching gears in respect of helix angle (whose value in any gear varies with the cylinder on which it is measured), but of matching axial pitches. A pair of helical gears to be cut by hobbing can always be designed so that the ratio of their common axial pitch to the pitch of the hob saddle feed screw is one of small whole numbers, and in that case there is no difficulty in providing gears that give exactly the desired ratios in the lead and index trains if a differential mechanism is used. If not, that facility disappears, as the indexing change gear formula takes up the more complicated form shown by Mr. Couling; it is usually possible to discover change gears that satisfy it with adequate accuracy, but only rarely can they be exact. Furthermore, the feed change gear ratio has also to be accurate, whereas when the differential is used, that ratio has no effect on the accuracy of the product.

By avoiding the use of the differential mechanism a train of gears (numbering seventeen in the case mentioned by Mr. Couling) is eliminated, but it must not be assumed that this makes any perceptible reduction of error in the final product. In most hobbing machines gears in the differential and its drive would have to be grossly inaccurate to produce any bad effect on the work. The accuracy of a mechanism cannot be assessed by any such simple process as counting the number of gears in it.

Because it permits rationally designed gears to be cut with change gears of exact ratio, the differential mechanism offers a slight advantage in accuracy besides the very great practical convenience of eliminating a severe restriction on choice of feed rate.

W. A. TUPLIN, D.Sc., M.I. Mech. E.

Huddersfield, August 12th.

LOCOMOTIVE INTERCHANGE TRIALS

SIR,—I have been interested in the recent correspondence regarding the locomotive interchange trials, and note that one correspondent connects the high coal consumption of the Bulleid "Pacifics" with the flat fronts of the locomotives.

I suggest that the piston valves may be another cause.

As most of your readers must know, outside steam admission is employed. When the engines first came out, the motion operating the middle valve broke as the pressures on the opposite ends of the valve did not equalise. As a remedy, two steam pipes of 12·6 square inch cross section were placed joining the front and rear steam chests.

This prevented further breakages, but whether the compensation was adequate in view of the large size of the valves and the high piston speeds is a matter requiring careful investigation.

D. M. PEARSON

London, S.E.24, August 11th.

BEHAVIOUR OF CAST STEEL AT "ELEVATED" TEMPERATURES

SIR,—Of all the jargon and catchwords we have to put up with at the present day none is more repugnant than "elevated" temperatures. Why this should have displaced the correct and better "high" temperatures is a mystery, and I hope it will be discontinued. Before long I am quite expecting to see a paper being read on plant to stand "escalated" pressures.

A. B. SCORER, M.I. Mech. E.

Salford, 6, Lancs, August 10th.

COLD CATHODE LIGHTING

SIR,—Referring to your description, on page 53 of the July 8th issue, of cold-cathode tube arrangements at the G.E. Laboratories at Wembley, I feel that company would not really suggest that the louvred scheme was "believed to be the first installation."

During a recent tour of the U.S.A. I observed that practically every installation used this arrangement and some were much more highly developed. ALAN DOUGLAS

Sheffield, 3, July 19th.

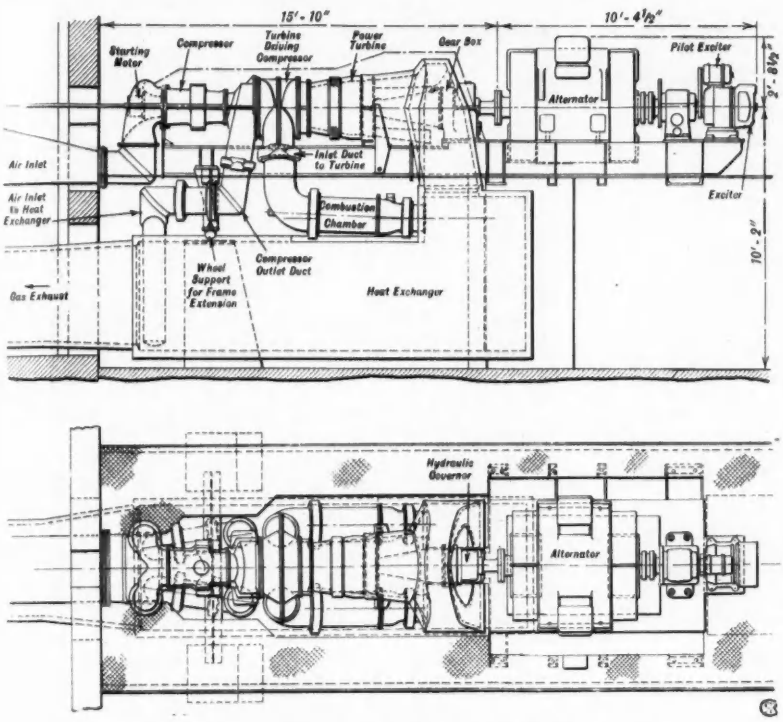
[The phrase quoted should have been qualified with the words "in this country."—ED., THE E.]

"INDUSTRIES OF ENFIELD."—In comparatively recent years there has been rapid development of a variety of manufacturing industries in the outlying areas of London. Much information about the industrial development of one of those areas—Enfield—is presented in a book entitled "Industries of Enfield," which has just been published by the Enfield District Manufacturers' Association. In its 160 pages, the book gives details of the products of about ninety large and small manufacturing concerns in the district, and also includes some interesting history of the town and its environs. The book costs 5s. 6d. and is obtainable from the Secretary of the Association, Mr. J. Edwards, 6, Palace Gardens, Enfield, Middlesex.

The Ruston and Hornsby Gas Turbine

IN the course of our annual review of gas turbine development during 1948, we were able in our issue of January 28th last to announce that the firm of Ruston and Hornsby, Ltd., of Lincoln, had begun the construction of a gas turbine which would be used as a base load generating unit in the firm's own power-house. We are now able to give some further particulars of this interesting new prime mover, a model of which will be exhibited on the Ruston and Hornsby stand at the forthcoming Engineering and Marine Exhibition to be held at Olympia from Friday, August 26th till Saturday, September 10th. At the end of the war, the firm realised that the research which had been carried out on aircraft gas turbines had paved the way for the design and development of general purpose industrial gas turbines, based on entirely new conceptions of weight and efficiency.

Early in 1946 the Ruston organisation had already secured the services of several engineers who were actively engaged in the design and construction of aircraft jet engines during the major part of the war, and a gas turbine design department was established at Lincoln, apart from the main oil engine design department of the firm. The prototype unit, designed for a full power rating of 1070 b.h.p. was completed in the early months of this year and, as shown in the engravings on page 204, it has been installed in one of the firm's power stations. Comprehensive tests were started in June, and as soon as the test programme has been completed the turbine unit driving its 750-kW alternator will be employed as a base load generating set.



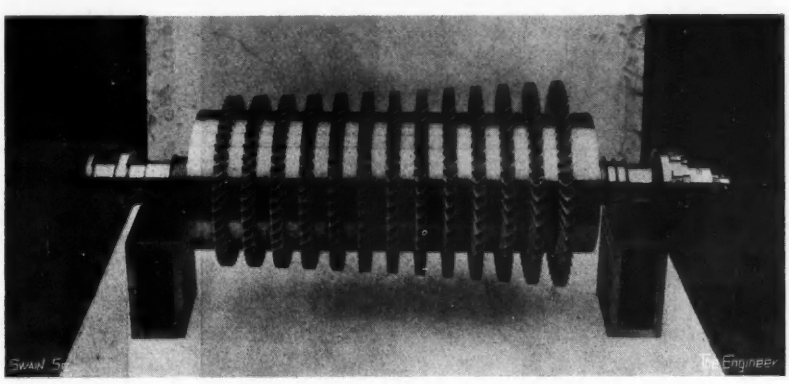
GENERAL ARRANGEMENT OF 750kW GAS TURBINE PLANT

Early oil engine and steam plants of equivalent power are railway locomotive work, portable power plants for transport by rail or road, and stationary plant for power generation, in particular for regions in which water supply is scarce or not available.

The basic principles that were carefully

Design and General Lay-Out

The design produced is claimed by the firm to be one of the first British gas turbines to be designed throughout as a long-life prime mover and put on the market. The size and output was chosen to fit in with the firm's productive resources, and it is of interest to record that, as its gas turbine activities have become known, the enquiries received have shown that there is a considerable demand for gas turbine power plants, in which low fuel consumption is secondary to lightweight construction, portability and ease of maintenance. Possible applications in which the Ruston gas turbine shows to advantage over



ROTOR FOR 13-STAGE AXIAL FLOW COMPRESSOR

weighed in the design were those of long life, simplicity, low first cost, and good efficiency from full load, down to below half-load.

It was decided to adopt a thirteen-stage axial flow compressor, on account of its high adiabatic efficiency. The compressor delivers air through a contra-flow tubular heat exchanger to the two combustion chambers. The two-stage turbine which follows supplies its entire output to the air compressor and its exhaust is then passed through a two-stage power turbine, which delivers power to the driving shaft through epicyclic reduction gearing. The exhaust from the power turbine is ducted back through the heat exchanger and is then passed to the atmosphere. The general arrangement of the turbine and its alternator is clearly shown in the accompanying drawing and the engravings reproduced on page 204.

In choosing the thermodynamic cycle, it was proposed to keep a fairly low maximum gas temperature, to ensure low blade stresses. Two-stage turbines were found to meet the desired design condition and they give a better turbine efficiency at partial loads. The arrangement was so contrived that with a little modification the unit could be operated either with or without the heat exchanger, thereby making it readily adaptable for peak load or similar duties where the tubular pattern of heat exchanger might prove too bulky.

With a maximum gas temperature of 1370 deg. Fah. and a compression ratio of 4 : 1, assuming an effectiveness of 75 per cent for the heat exchanger at full load, the plant efficiency works out at 24 per cent, falling to about 18½ per cent at 40 per cent load. If, however, the turbine plant is run without a heat exchanger the efficiency falls to about 17½ per cent at full-load and to 11 per cent at 40 per cent full load.

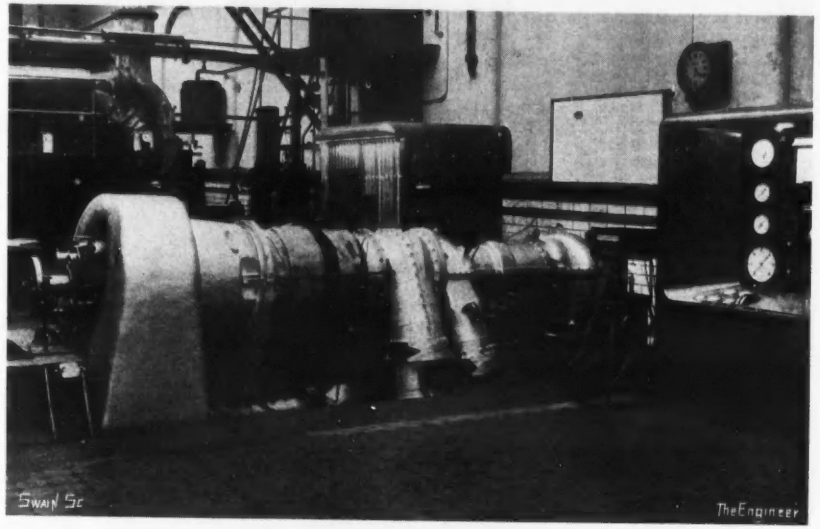
With the heat exchanger the maximum full load output is 1070 b.h.p. and without the heat exchanger the load is increased to 1250 b.h.p. at the gearbox output shaft.

The drawing we reproduce and the photographs of the unit in the power-house show the neatness of the installation. For alternator driving, the mechanically independent power turbine is a great advantage, as a reduction in power output can be obtained by reducing the speed of the compressor high pressure turbine shaft, which in turn reduces the temperature, quantity and pressure of the gas at the power turbine inlet, whilst the speed of the power turbine, which is directly coupled to the alternator, remains constant. Referring to the drawing, it will be seen that the plant has been designed for installation in a power-house, with the floor line at the level indicated by the dotted line. The heat exchanger is placed in a position corresponding to that of the condenser of a steam turbine plant.

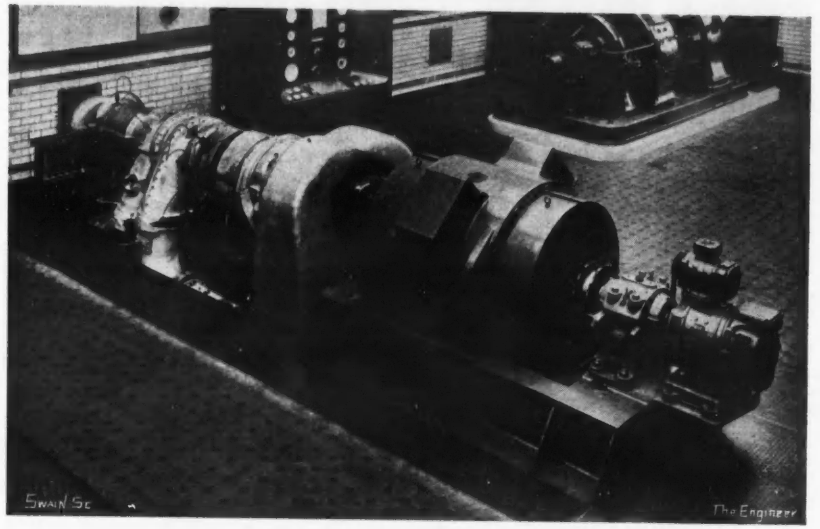
Owing to the way in which the components are sub-divided into the main assemblies of rotating components (including the compressor-turbine assembly) the power turbine and the reduction gearing, the main frame and the heat exchanger, the plant can with very little modification be adapted to fulfil many kinds of duties. For portability the heat exchanger can be arranged alongside the rotating components, instead of underneath them, so that the plant can be mounted on a flat concrete floor; alternatively, the heat exchanger may be omitted entirely, if there is a lack of space or if the power plant is intended for power generation in an emergency. Again, if needed, the heat exchanger

BASE LOAD GAS TURBINE GENERATING UNIT

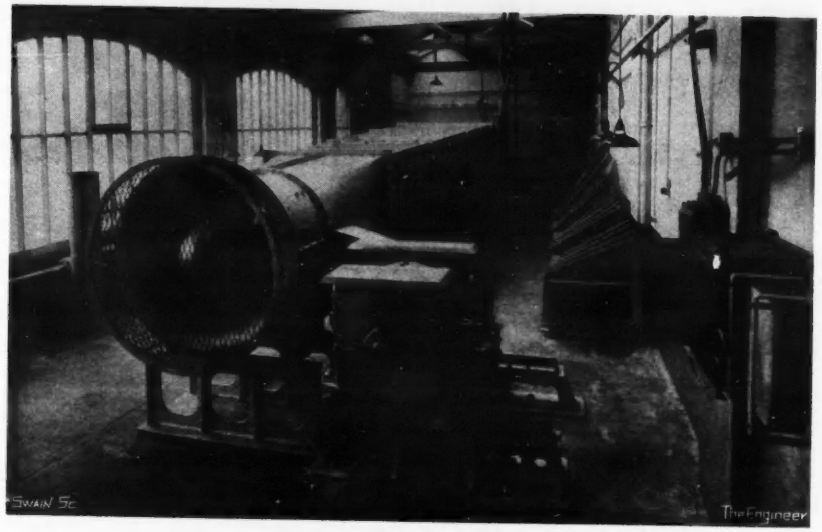
RUSTON AND HORNSBY LTD., LINCOLN, ENGINEERS



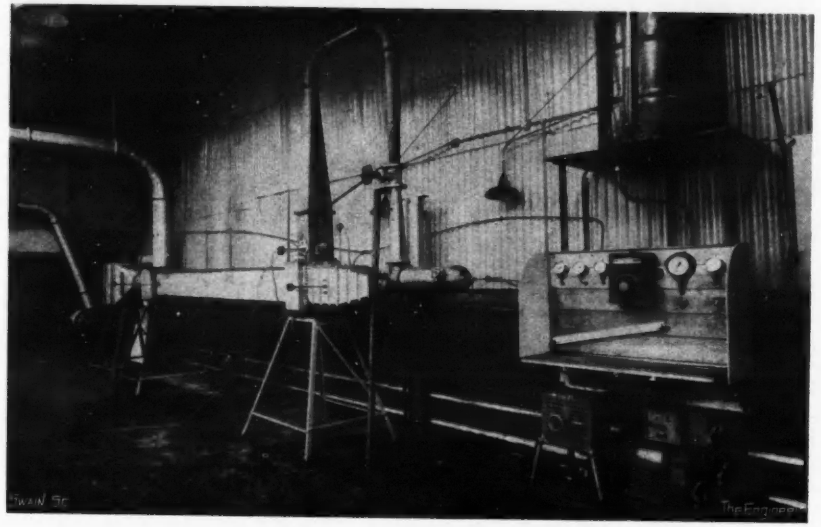
1,070 B.H.P. GAS TURBINE



GAS TURBINE WITH ALTERNATOR ON TEST



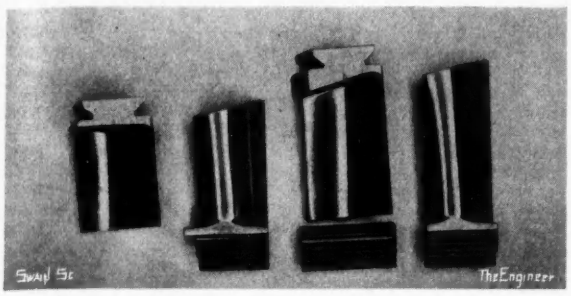
FAN END OF CASCADE WIND TUNNEL



RIG FOR TESTING HEAT EXCHANGER ELEMENT

can be added after the plant has been in operation for some time. In all cases it is unnecessary to provide very strong and elaborate foundations, such as are needed for an oil engine of comparable output, owing to the absence of vibration.

The arrangement described with the mechanically independent power turbine is particularly suitable as a prime mover for railway locomotives, whether the transmission be

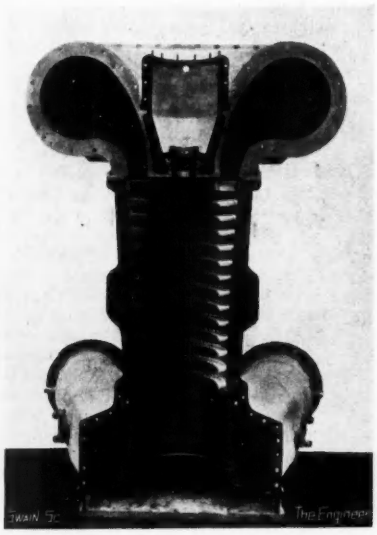


SPECIMENS OF TURBINE BLADES

direct mechanical or electrical. For such a plant a smaller heat exchanger may be used or that component can be omitted entirely.

For ship propulsion a heat exchanger will usually be required, but it can be disposed with the tubes vertical, the upper part of the heat exchanger occupying the lower part of the funnel.

With regard to the life of gas turbine power plants, it must be borne in mind that the permissible gas temperature on full load is the



COMPRESSOR CASING

same whether the plant is running with or without a heat exchanger. Thus the operating conditions of the turbine blades are the same and a similar service life will be obtained. So far as can be predicted from the tests already made and the available data, the service life of the most severely loaded turbine blades will be comparable with that which is now obtained with steam turbine blading.

Details of Construction

With the exception of the main frame, each of the main turbine assemblies, the compressor, compressor driving turbine, the power turbine, and the gearing, can be dismantled without having to interfere with any of the other groups. In all the gas ducts flexible couplings have been provided so that no stresses are transmitted between the various sections of the plant arising from relative movement due to thermal expansion. The heat exchanger is suspended from four tension bolts, the upper ends of which are seated on springs. Each of the gas and air pipes leading to the exchanger is furnished with suitable flexible joints, so as to allow movement in any direction. The main frame of the turbine unit is also used as an oil tank, an arrangement which leads to compactness and ensuros a uniform temperature notwithstanding stray radiation from the ducting.

The accompanying engravings show the rotor of the thirteen stage axial compressor, specimens of blading, and the lower half of the compressor casing, with the blading in position and the top and bottom inlets. We also show the rotor of the compressor-driving turbine and some of the nine bundles of heat exchanger tubes showing the end fixings.

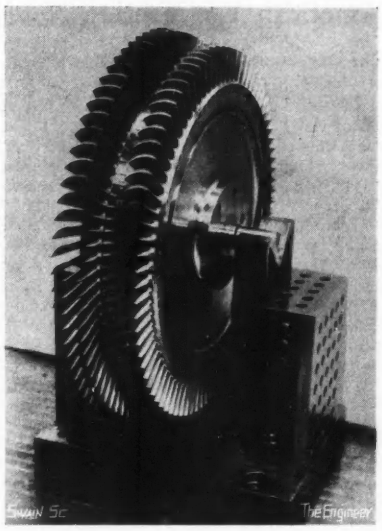
No water is required in any part of the plant for cooling purposes. The turbines are cooled by air bled from suitable points in the compressor, whilst the heat generated in the lubricating oil in the main bearings and the reduction gearing bearings is dissipated by means of a finned cooler, the fan motor of which is supplied from the a.c. mains.

Starting is effected by means of a 15 b.h.p. 24-V electric motor or by an air motor of equivalent power. Experience has indicated that the critical speeds of both rotor systems are substantially above those of the running range, and no difficulty should therefore be experienced in running the plant continuously at any load down to zero net output. The reduction gearing is double-helical epicyclic, and a ratio of 4 : 1 is used. Overspeed and safety devices form an integral part of the reduction gear.

Governing and Safety Provisions

A special governor has been designed, which enables three distinct types of governor response to be obtained from the standard governor unit. It provides for stable governing over the full load range at a constant speed, irrespective of load; for stable governing with a drooping speed characteristic, when the load is increased; and finally for de-tuned governing, suitable for driving an alternator, supplying current to a constant frequency grid system. Provision is made for three contingencies, the overspeeding of the compressor-turbine rotor, the overspeeding of the power turbine rotor, and failure of the lubricating oil pressure. The entire control system is operated by a hydraulic servo system, which is supplied from the main lubricating oil pump. The adoption of this arrangement makes possible the provision of alternative safety devices such as temperature control and a manual emergency stop if desired.

The fuel and lubricating oil pumps are driven from the same electric motor. This motor, as an additional safety precaution, is supplied with



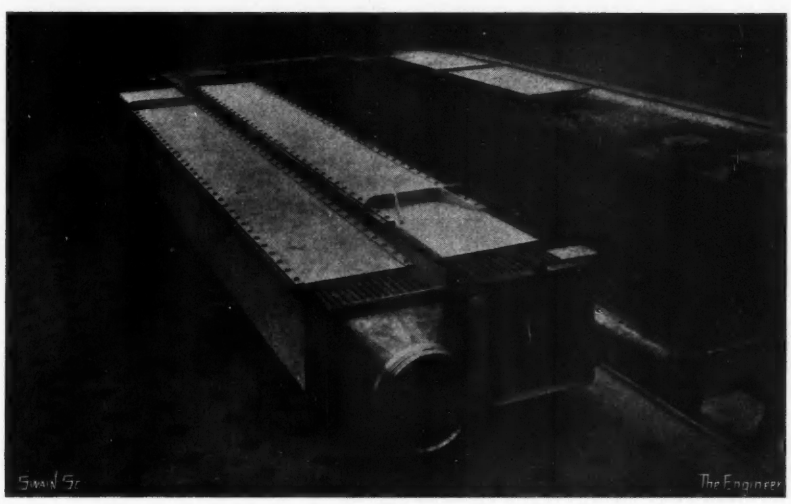
COMPRESSOR-DRIVING TURBINE

alternating current from the mains. The fuel system has been designed to operate satisfactorily with fuels of a wide range of viscosity and the development of a combustion chamber to burn the heaviest grade of residual fuel is now in an advanced stage.

The weight of the complete plant we have described and illustrated is, as installed in a power station ready for service with the alternator, 17½ tons.

The Gas Turbine Design Department

From our description it will be gathered that despite the other work going through the Ruston Hornsby factories it has been possible to design, manufacture and test the gas turbine quickly without having to drawn upon much personnel from the administration and works engineering sides. On the technical side, however, as already mentioned, a special design department has been set up. A considerable amount of specialised experimental equipment is available for providing advance information on the performance of new components. That equipment includes a wind tunnel for carrying out cascade tests on compressor and turbine blading and a heat ex-



HEAT EXCHANGER TUBE BUNDLES

changer test rig. A view of these special appliances is given in two of the engravings on page 204. Other apparatus designed and used by the department includes a duct test rig for research into diffuser and duct design, and also a combustion test rig.

American Engineering News

Idaho 30-Mile Tunnel Scheme

Construction of a 30 miles long tunnel to form part of the 192,000-acre Payette unit of the Mountain Home irrigation project, near Boise, is under consideration. The tunnel, which would have a maximum diameter of 19ft, would be horseshoe-shaped, lined with 18in of concrete, and would extend from the upstream end of Carden Valley, near Banks, Idaho, to Moores Creek, in the Boise River basin, the route passing through several mountain ridges. It would have a fall of 137ft, or 4½ft to the mile, and a maximum capacity of 2700 cubic feet per second. The water would have a velocity under free-flow conditions of 10 cubic feet per second. Shafts 20ft in diameter and in some cases as much as 1150ft deep, would be built along the route of the tunnel to permit work to be carried forward simultaneously in several areas. Although actual construction will depend on whether the project is found to be economically feasible, the Bureau of Reclamation consider that the tunnel plan would reduce operation and maintenance costs, permit fuller utilisation of waste waters of the Payette River, and make available about 75,000kW of additional installed power capacity. It is estimated that the scheme would require from six to eight years for completion.

Tunnel on Penn-Lincoln Highway

A twin tube vehicular tunnel approximately four fifths of a mile in length, is being driven under the Squirrel Hill residential district of Pittsburgh to form an important link in the Penn-Lincoln parkway system. The parkway itself is designed to ease the present congestion of traffic approaching and leaving the city, and the tunnel is the largest project ever to be put under contract by the Pennsylvania Department of Highways. The tunnel will be of twin tube, concrete-lined construction, 60ft from centre to centre, each tube being 29ft 8in wide, and will carry a two-lane roadway and a service walkway. The lining of the tunnels will be reinforced concrete 1½ft thick at the sides and 1ft 9in at the top. The total length from portal to portal will be 4225ft, of which 3385ft will be driven through rock by drilling and blasting. The remainder of the length will be cut and cover sections at each end. It involves approximately 400,000 cubic yards of excavation, with fills up to 100ft and cuts of 40ft. The rock excavation will amount to 249,278 cubic yards and approximately 102,400 cubic yards of concrete will be required. Started in September, 1948, the tunnel is due for completion in September, 1950. Work is proceeding in the excavation of the tunnel at the rate of approximately 20ft per day.

New Passenger Liners

The keel of the second of the two 20,000 ton liners being built for American Export Lines at the Bethlehem Steel Company's yard in Quincy, Massachusetts, was put down early this month. Work on the first of these two liners, which will be named "Constitution" and "Independence," began late in March at the same shipyard. The two liners are being built at a cost of 47,000,000 dollars and are expected to be ready for service in the autumn of 1950. With a speed of 25 knots, they will each accommodate 1000 passengers in three classes. They are designed for service between New York and the Mediterranean, and are expected to be two of the largest and fastest ships of their type afloat. They are being constructed under the terms of the Merchant Marine Act of 1936, and American Export Lines claim to have spent nearly 1,000,000 dollars in development work on this new-type vessel to assure success in trans-atlantic operation. The company also claims to be the first line to co-operate with the United States Maritime Commission in building new large passenger liners since the end of the war.

Link in Proposed U.S. Expressway

Detailed plans have now been completed by the Pennsylvania Turnpike Commission for its section of a projected cross-country super highway. New Jersey and Ohio are also working on the scheme, which, when completed, will provide a high-speed expressway without crossings from the vicinity of the Hudson River traffic tunnels at New York to the Indiana-Ohio boundary. It is expected that the Central and Western States will, in turn, extend the highways westwards. Using as a starting point the original Harrisburg-Pittsburgh Pennsylvania Turnpike, the Commission in Pennsylvania is now building an extension between Harrisburg and Philadelphia, which should be completed next summer. Plans for a western extension to the Ohio border have been completed, and work on this section of the road will be started towards the end of this year, with the opening scheduled for 1951. Tolls on the 326-mile run of the turnpike across Pennsylvania are expected to be slightly less than one cent a mile. When completed, the Pennsylvania link in the proposed cross-country four-lane expressway will extend from Philadelphia to Petersburg, Ohio, just south of Youngstown, and at seven different points will be taken by tunnels through the Pennsylvania mountains. It will cost an estimated 200,000,000 dollars, most of it financed by revenue bonds.

New Atlantic Beach Bridge

To overcome one of the worst bottlenecks for traffic bound for the South Shore of Long Island, work on the construction of a new six-lane Atlantic Beach Bridge is to begin later this year. The bridge is estimated to cost 6,000,000 dollars and is expected to be ready for traffic by the summer of 1951. The present three-lane Atlantic Beach span over Reynolds channel has long since been inadequate to cope with present-day traffic needs, with cars at peak periods on Sundays lined up for more than a mile from the toll houses. It has also contributed to congestion on Rockaway Boulevard and the Belt Parkway, the feeder lines to East Rockaway and nearby communities. The new bridge will have 11ft traffic lanes, compared to the 9ft lanes of the existing twenty-two-year-old structure. Furthermore, it will be a high-level bascule-type bridge, with over 30ft clearance above the water. With only 15ft clearance, the existing bridge has to be raised and lowered over 100 times a day to enable traffic to pass through the State Boat Channel. As soon as the new bridge is completed, work is expected to begin on the 15,000,000 dollar Nassau expressway, which will start at the Van Wyck expressway in Queens, the main link to the New York international airport at Idlewild.

Mystic River High-Level Bridge, Boston

Work on the high-level Mystic River bridge in metropolitan Boston, Massachusetts, which was begun in March, 1948, and is estimated to cost 27,000,000 dollars, is now well under way, being due for completion in the spring of 1950. Already the work has called for the placing of fourteen major contracts by the Mystic River Bridge authority, which was created to supervise the scheme. The new bridge is intended to replace the existing bridge, which carreis traffic between the thickly populated north-shore area of Boston and the central business section of the city. Frequent openings of the draw span over the Mystic River channel causes considerable delay and congestion to traffic using the bridge. Each time the bridge has to be opened, traffic jams extend for several blocks in each direction. The new high-level span will obviate most of this congestion. Beginning at its southern end in Charleston, the existing bridge first spans the Little Mystic channel, where it is known as the Chelsea South Bridge, and then crosses over a jutting peninsula of land above the marshalling yards of the Boston and Main Railroad to continue northwards over the main channel of the Mystic River to provide what is known as the Chelsea North Bridge. Both these low-level bridges have to be opened for every ship navigating the river, and traffic censuses show that the larger bridge is opened more than 7000 times during a year. With the completion of the new high-level bridge, the Chelsea North Bridge will be removed, but the South Bridge is being retained to give access for local traffic to the Boston and Maine Railway yards and to the docks. The new bridge is being built slightly westwards of the old structure but close enough to enable the latter to be used for such operations as the placing of concrete in the river piers. The new bridge will be a double-deck structure with a total length of 11,700ft, providing three lanes of traffic in each direction, the north-bound traffic being carried on the lower deck and the south-bound on the upper deck. The major unit of the bridge, which crosses the Mystic River, is a three-span through-truss cantilever structure, 1524ft long and consists of an 800ft main span flanked on each side by anchor arms 361ft long. This main span embodies a 387ft 6in suspended span with 206ft 8in cantilever arms on each side, which forms a navigation opening having a vertical clearance of 135ft above mean high water for a 700ft width. Over the Little Mystic River channel the bridge is a single, simple double-deck through-truss span, 439ft long, with a vertical clearance of 100ft. Another interesting feature of the scheme is the toll plaza, which, owing to limitation of space, is having to be erected between the two over-water spans in the yard of the Boston and Maine Railroad. Designed to accommodate seven toll lanes on each level, it is on an elevated steel structure, the top of which is 140ft above the ground. The minimum vertical roadway clearance of each level both at the plaza and throughout the bridge, is 16ft. The approaches to the river and channel span, and to the toll tower, are formed of double-deck bent girders supported on steel pins.

Pecos High Bridge, Texas, Replaced

For many years the highest railway bridge in the United States, the Pecos High Bridge of the Southern Pacific Railroad, situated near Comstock, Texas, which has now been replaced by a new steel cantilever structure, is now being dismantled. As originally built by the Phoenix Bridge Company for the Galveston, Harrisburg and San Antonio Railroad, which now forms a part of the Southern Pacific system, the bridge was 2180ft long and 321ft above the low-water level of the Pecos River Canyon. It comprised two cantilever arms each 85ft long, two tower spans each 35ft long, two lever arms 52ft long, and one 80ft suspended span. There were also eight lattice spans, each 65ft long, one plate-girder span of 45ft, and thirty-four girder spans 34ft in length. For the dismantling of the old bridge, a cableway consisting of a 2¼in diameter cable has been suspended between two 130ft steel towers built at each end of the bridge. This cable is being used to support the centre span of the bridge while it is being cut in two pieces for lifting out. After this span has been removed, each of the two outer members will be lifted out section by section in the same manner. The new bridge consists of two 80ft deck plate girder spans, two 160ft 6in anchor arms, continuous with two 260ft 6in side spans, and a central cantilever span 374ft 6in long.

YOUNG TROPHY.—Competed for annually by the London Students' Sections of the Institutions of Civil, Electrical and Mechanical Engineers, the Young Trophy has this year been won by the Electricals. After winning the shooting competition, coming second in table tennis and third in soccer, the I.E.E. students found the summer to their liking and beat both their opponents at cricket and at lawn tennis to win the cup with 30 points out of a possible 40.

Electric Power Engineering in Germany, 1939–45*

Introduction and Summary

Prior to the outbreak of war in 1939 the German electric power engineering industry was well developed and its products were of a generally high standard. During the war the industry was handicapped by shortages of labour and of certain raw materials and by Allied bombing. The shortages of raw material led to intensive experiments with the use of substitute and synthetic materials, but, in general, technical developments during the war were limited, and it is only in a few matters of detail that German practice at the end of the war was materially in advance of that in Britain.

As might be expected, the principal differences between German and British practice arise from the different circumstances in the two countries. Thus the Germans have for many years found it desirable to use transmission voltages higher than those used in this country and at the end of the war had over 3000 miles of 220-kV line, whereas the highest voltage in use in Britain is 132kV. The Germans thus have considerably greater experience in the use of 220-kV switchgear, transformers and other transmission equipment.

German schemes for large-scale development of European water power resources led to intensive research in the use of still higher voltages, and, at the direction of the Government, a committee was set up to investigate the possibility of transmission voltages of 400kV and more. Research was at first carried out both for a.c. and d.c. transmission, but later the main effort was directed towards d.c. transmission.

For many years Professor Marx had been experimenting with his contact rectifier, but no solution could be found for the problem of rapid wear of the contacts. Experiments were therefore started by Siemens-Schuckertwerke A.G. (S.S.W.) and Allgemeine Elektrizitäts-Gesellschaft (A.E.G.) using single-anode, pumped, liquid-cooled, mercury-arc rectifiers of the "Excitron" type; the S.S.W. rectifier using graphite anodes and grids, provision being made for controlling the potentials of the upper grids by means of a capacity type potential divider, while the A.E.G. rectifier used iron anodes and grids, the potential divider grids being left floating. In the latter stages of the war it was felt that progress with these rectifiers was sufficiently promising to justify a full-scale test, and accordingly a 70-mile length of cable was laid between Berlin and a new generating station which had just been completed on the River Elbe. This was an ordinary solid-cable, paper insulated and oil impregnated, with a dielectric thickness of only 15mm and designed for 150A, 200kV. The terminal equipment was to be supplied by S.S.W. at one end of the cable and by A.E.G. at the other, but, due to military action, the circuit was never brought into operation.

By force of circumstances the Germans experimented with many types of substitute and synthetic materials, but while some appreciable successes were obtained it was seldom that the substitute proved generally better than the original material. Perhaps the most significant development work of this type in the electric power engineering field was that done to discover a substitute material for lead for moisture-proof cable sheathing. A horizontal press was designed by Schloemann to produce extruded seamless aluminium sheathing and appears to be of sound design. This development is important, not merely because of the world shortage of lead, but also because of the possible saving in weight and increase in strength of the resultant cable. In addition, several other methods for replacing lead sheathing were tried and deserve study.

While in general the German cable industry is technically inferior to that of Britain, they compiled a mass of technical data on synthetic and substitute materials such as Buna rubber and P.V.C. Other instances of substitution which appear promising are the use of "Zellwolle," prepared from spun cellulose fibre, in place of cotton for braiding yarns and tape, and the use of tungsten carbide dies, in place of diamonds, for hot extrusion.

Again, in the battery field, lack of certain battery material led to the development of substitutes; for instance, shortage of manganese dioxide depolariser for Leclanché cells forced the Germans to develop the air depolarised type, which actually proved more satisfactory for wireless H.T. batteries though not for flashlamps.

The Germans have more experience in the use of extra high-pressure steam and there are many plants in Germany working at 1400-2000 lb. per square inch absolute. For these high-pressure units the radial flow type of turbine is generally employed, the design used being that of M.A.N of Nürnberg rather than that of S.T.A.L., of Sweden. Considerable, and not very successful, experiment has been made in Germany with regard to turbine blade material, and ceramic and other non-metallic materials have been tried for gas turbines.

A major development in synchronous machine construction was the production of a two-speed water turbo-alternator, motoring or generating at either 136·5 or 167 r.p.m. by making a pole change from thirty-four to forty-four poles; this enables the turbine to be run near the optimum conditions with variable water head. The Germans have also achieved some developments of particular interest in large, high-speed d.c. machines. On the other hand, there has been little advance in insulating materials for machine use, the major point of interest being the use of cellulose triacetate for low-voltage slot insulation.

Germany has used small-oil-volume and air-blast circuit breakers and two-post isolators to a far greater extent than has Britain, and for some years bulk-oil circuit breakers have not been built. While German practice is not in general in advance of British in this sphere, there is much to be learned regarding the details of design of multi-break heads, air-blast valves, operating mechanisms, series-air-break switches, air drying methods and operating experience. Pneumatic operation is used almost exclusively for non-automatic isolating switches, sequentially operated series-air-break switches and closing of circuit breakers; spring opening of circuit breakers is usual and solenoid operation is used little, if at all.

The two most interesting switchgear developments in Germany are the A.E.G. "hard gas" circuit breaker for voltages up to 20kV with a short-circuit duty of 200MVA, and the B.B.C. (Brown, Boveri et Cie) five-break and eight-break air-blast circuit-breaker heads for 110kV and 220kV with a rating of 2500MVA. Recent improvements in the widely used S.S.W. "expansion" breaker using two breaks per phase with resistors of 1500–3000 ohms in parallel with the first break are said to have increased its rupturing capacity to 3500MVA (110kV) and 4000MVA (220kV).

German practice with regard to transformers is generally behind British, although the German manufacturers have had the advantage of a higher grade of iron enabling the loss at a flux density of 10,000 lines per square centimetre at 50 c/s to be 10 to 20 per cent less than for British transformers. The Germans have had more experience with transformers for 220kV and with transformers having more than one winding than have manufacturers in Britain; they operate their transformers with slightly higher flux and current densities than do the British. German porcelain and steatite have better mechanical strength than British.

In battery construction perhaps the most important development in Germany during the war was a new type of nickel-cadmium cell in which both positive and negative plates were made from sintered materials of a highly porous structure reinforced by wire mesh built into a steel frame and segregated by P.V.C. thread. This type of cell might be expected to have a lower capital cost and lighter weight than existing types of alkaline cells, even though it might not have a longer life.

Steam Turbo-Alternator Sets

There are only three main builders of large turbo-alternators in Germany, namely, the Allgemeine Elektrizitäts-Gesellschaft (A.E.G.), Siemens-Schuckertwerke A.G. (S.S.W.), and Brown, Boveri et Cie A.G. (B.B.C.), as compared with six in Britain. German practice is therefore less heterogeneous.

Less attention has been given by manufacturers in Germany to the improvement of the efficiency of steam turbines than has been given in the United Kingdom, and the efficiency of German machines is considerably below that of British plant.[1] The German manufacturers have, however, made more progress than British firms in the use of extra high-pressure steam, and as long ago as 1935 several plants were at work, using steam at a pressure of 1400 lb per square inch. Plant using pressures of this order usually consists of two separate units, a high-pressure, high-speed machine exhausting at a medium pressure into a separate unit worked in parallel on this lower pressure with earlier units in the same station. Both the high-pressure and the normal pressure units are generally provided with separate governor gear, &c., so that the normal pressure unit can be run entirely separately from its associated high-pressure unit.

For these high-pressure units S.S.W. use turbines of the radial-flow type. These are generally in accordance with the design for this type of turbine developed by M.A.N. of Nürnberg and not to the design of S.T.A.L. of Finspong, Sweden.

A considerable amount of development work has taken place in Germany with regard to turbine blade material. Experiments were made with ceramic blades for gas turbines,[2] but these do not appear to have been very successful. Some of the materials could only be used for temperatures below 700 deg. Cent., and, furthermore, could not be used in an orthodox rotor assembly as their tensile strength is limited; they also proved to be very susceptible to heat shock arising from sudden changes of temperature. Several German firms also experimented with other non-metallic materials for turbine blades.[3] In some cases a certain amount of iron was mixed with the alumina, and as this mixture withstood heat shock it held out some promise of being successful, but its strength appeared to deteriorate quickly under conditions of prolonged loading.

The radial-flow type of turbine was originally manufactured in Germany to the design of S.T.A.L. of Finspong, but later a modified design was evolved by M.A.N. of Nürnberg. The latter company has manufactured a number of units with capacities ranging from 20MW to 45MW and operating at steam pressures from 14 to 41·5 atmospheres, the highest steam temperature being 450 deg. Cent. M.A.N. have also built a few high-pressure, back-pressure sets, the highest inlet pressure being 110 atmospheres and the highest temperature 500 deg. Cent.[4]

German a.c. generators do not differ in any major respect from British machines. The highest voltage German machine is 22kV, whereas many British units for 33kV have been in successful operation for many years, so that in this respect Britain is far ahead of Germany.

Hydrogen cooling has only been adopted on an experimental scale in Germany and is not considered to be justified for sets with capacities below 50MVA operating at 3000 r.p.m. S.S.W. built a 10-MVA hydrogen-cooled machine to investigate hydrogen technique, but no commercial units have yet been supplied. In this respect, therefore, Britain is ahead of Germany, although the German makers would be prepared to build hydrogen-cooled machines of 70-MVA capacity and would probably have been doing so but for the war. Dr. Leukert, of S.S.W., has pointed out that the reduction in losses by the use of better core iron and reduction of stray losses by suitable non-magnetic parts can be shown to be as great as that obtained by the reduction of windage losses at 50 cycles by hydrogen cooling.

The majority of German machines above

* Abstract. B.I.O.S. Overall Report No. 11. His Majesty's Stationery Office, London.

30MVA are equipped with damper windings; not only in the top of the exciting winding slots, but also in pole face slots.

Rotors of 39in diameter used for large two-pole machines are single-part chrome-nickel-molybdenum steel forgings with a yield point of about 35 tons per square inch. Rotor ventilation systems vary considerably. S.S.W. drill axial holes the whole length of the rotor teeth communicating with radial tooth holes for discharging air at the centre of the stator. A.E.G. machine taper slots in the teeth and close these slots with wedges to form an air duct. B.B.C. use no rotor ventilation ducts and claim satisfactory operation.

All three firms admit rotor copper distortion, but express no concern. S.S.W. claim that their present system of rotor ventilation keeps the winding sufficiently cool to prevent distortion, but they use hard copper for the upper turns in the slot.

The service records of German a.c. generators appear to have been very good, but the multiplicity of protective devices in the latest machines indicates that there may have been a good deal of minor stator and rotor trouble which was not recorded in station logs available to British investigators.

Water Turbo-Alternator Sets

The design of the 19·6-MVA, two-speed water-wheel alternators for the Hohenwarte power station represents a major development in the construction of this type of plant. These machines motor or generate at either 136·5 or 167 r.p.m. by making a pole change from thirty-four to forty-four poles. This enables the turbine to be run near the optimum conditions, with variable head in the reservoir. These machines have a distributed exciting winding, but S.S.W. have carried their pole change principle further by experimental work on salient pole alternators. The pole change is made by a combination of short circuiting certain poles and reversing the excitation of others. The resultant flux field form has pronounced harmonics, but these are eliminated from the e.m.f. wave by suitable stator chording.

Induction Motors

S.S.W. constructed the largest 3000 r.p.m. induction motor built in Germany. This is a 5500-kW star/delta-started, squirrel-cage machine driving a Demag compressor. The rotor is single cage and gives 40 per cent of full-load torque with 220 per cent full load current at starting. The output coefficient is 2·6 (kW/Bore metre^3 r.p.m.).

At the lower end of the range on standard motors, there has been considerable activity in totally enclosed, fan-cooled machines.

Designs generally embrace three types. Up to 10–15kW, four-pole machines are built without internal air circulation other than local eddies produced by wafter blades on die-cast rotors. External air is usually blown over the outside of a longitudinally ribbed, cast frame, although one case was noted of air blown over the outside of a plain rolled shell frame. For larger sizes up to about 250–300kW, four-pole, internal air circulation through the rotor and over the back of the stator core is introduced; the ribbed frame with external blow-over air still being used. For larger sizes up to about 700kW, four-pole, a neat construction has been introduced by S.S.W. involving a single layer of axial tubes all round the periphery of a fabricated frame. External air is blown by a fan on the shaft through the tubes, while the internal air circulation is round the outside of the tubes.

German induction motor manufacturers have made extensive use of the die-cast aluminium rotor, and employ this for the majority of rotors up to 250mm diameter. Both centrifugal and pressure methods of casting are used, but of nine firms inspected using cast rotors seven used pressure machines, one used centrifugal and one static casting, all firms casting up to 185mm diameter. Above this size, centrifugal casting is generally used—all the pressure machines inspected were by Polak, of Prague. Opinion as to the casting method giving the best motor performance is inconclusive. However, the design authorities of S.S.W. and A.E.G. are generally of the opinion that centrifugal casting gives higher starting and run-up torque and lower slip.

General Industrial Synchronous Machines

Various developments have taken place with the object of improving the starting performance of synchronous motors. A.E.G. built a 3200-kW, 1000 r.p.m. synchronous motor, with an all-steel bar starting winding with continuous steel end rings. The poles were laminated. The high-resistance steel gave a very satisfactory starting characteristic.

An interesting construction by B.B.C. involves solid poles without starting windings, but with copper blocks bolted to the pole tip ends. This increases the starting torque by about 25 per cent above the bare solid pole figure. This device has been used on a 2000-kW, 1500 r.p.m., synchronous motor.

An interesting project was successfully carried out by S.S.W. in running a 10-MVA, 94 r.p.m. gas-engine-driven alternator at a resonant frequency very close to the impulse frequency. The natural period of the alternator at full load is about 57 cycles per minute and at no load between 47 and 50 cycles per minute. The impulse frequency is 47 cycles per minute. The machine runs satisfactorily, however, by reason of the heavy damper winding, the damper bars cross section being 30 per cent of the stator copper cross section.

D.C. Machines

Large, high-speed d.c. machines built in Germany are of particular interest. The statement was made both by A.E.G. and S.S.W. that single armature generators of kW × r.p.m. $= 3·6 \times 10^6$ with 100 per cent momentary overloads are practicable. Table I gives machines typical of recent practice.

These large, high-speed machines make use of double-lap windings with $a = 2p$ to reduce the volts per bar on the commutator, which has twice the number of bars required by a normal lap winding. The average volts per bar are thereby kept to about twelve for heavy industrial use, but for the 6200-kW wind tunnel motor, S.S.W. have used 19V per bar average. S.S.W. have used the double-lap winding extensively, but adhere to an odd number of pole pairs giving a winding which only closes on itself after two progressions round the commutator. A commutator step of two must be used with these double-lap windings. B.B.C. have used both odd and even pole pairs. A.E.G. have not made much use of the double-lap winding, but have built the experimental 2500-kW motor mentioned in Table I to study the performance of this winding and methods of obtaining satisfactory equalising.

There is divergence of opinion between S.S.W., A.E.G. and B.B.C. on the benefits of slot dampers. S.S.W., who have had most experience with this device, are of the opinion that for high speeds and variable loads the use of slot dampers permits an increase of 30 per cent in the ampere conductors per centimetre of periphery. S.S.W. do emphasise, however, that for machines with steady loads the damper confers no advantage.

An interesting trend in development by both A.E.G. and S.S.W. is the use of forced air cooling of commutators by bringing air ducts to the brushes and keeping the commutator air separate from the armature air. Continuous peripheral speeds of 50m per second and over are considered practicable by this method.

A d.c. machine application of major interest is the continuous hot strip mill at Dinslaken. This is a six-stand mill, each stand powered by a close regulation 2200-kW, 360/720 r.p.m., twelve-pole, 785-V motor. Each motor is fed by a separate grid-controlled rectifier. Grid control is used for starting and the motors normally run at full voltage with automatic grid control responsive to the voltage on the l.t. side of the rectifier transformer to deal with transformer regulation and h.t. supply variation. The system of a separate as opposed to a common d.c. bus was adopted on the grounds of reduction in trouble resulting from backfires. This basic arrangement has operated satisfactorily, but considerable simplification to the rectifier control circuits installed by S.S.W. has been made by the mill electrical engineer. There is also a three-stand tandem cold mill at Dinslaken, also with a separate rectifier per motor, but this has, on the whole, not proved a success and the operating staff were of the opinion that the Ward-Leonard system would have been preferable for this latter application.

Traction Machines

The major activity in a.c. traction motors has been on 16⅔-cycle machines for the German railway system, but there have been some developments of interest in 50-cycle equipment. S.S.W. have built motors with a one-hour rating of 260kW per armature at 1890 r.p.m. for the Hollenthal Railway. These are double-armature motors having a total weight of 5 tons, equivalent to 10kg per kilowatt of continuous output. These motors have a maximum peripheral speed on the commutator of 55m per second. The major trouble with these motors is short brush life, brushes having to be renewed about every 6000 hours. Prior to the end of the war, experiments were proceeding to improve this situation. S.S.W. had under development a 50-cycle motor with a continuous rating of 480kW at 1310 r.p.m., and a maximum commutator peripheral speed of 62m per second. This had a total weight of 3600kg, equivalent to 7·5kg per kilowatt of continuous output.

The largest 16⅔-cycle motor was built by A.E.G. with a continuous rating of 730kW at 1310 r.p.m. and weighing 4·65kg per kilowatt of continuous output. The maximum commutator speed of this motor is 50m per second.

Garbe Lahmeyers, in collaboration with Krupp's, built some remarkable motors for the Hollenthal Krupp locomotive. This locomotive carries eight motors, of which four are special one-to-three-phase motors with a one-hour rating of 500kW at 1000 r.p.m., and four are slip-ring, three-phase motors of normal induction motor design with a one-hour rating of 500kW at 1470 r.p.m. The one-to-three-phase motors can either operate in cascade with the

Table I—*Large German High-Speed D.C. Machines*

Builder	kW, RMS	R.p.m.	Poles	Peripheral speed, metres/sec		Remarks
				Armature	Commutator	
S.S.W.	3550 (generator)	500	10	62	34	Reversing rolling mill duty; cut-out rating of 11,000kW
S.S.W.	6200 (motor)	220	18	42	34	Wind tunnel duty; 5 min overload of 11,000kW at 270 r.p.m.
A.E.G.	2380 (generator)	600	10	53	28	100 per cent overload momentarily
A.E.G.	2500 (motor)	750	10	59	30	Experimental machine; black commutation up to 2·2×FLC
B.B.C.	3250 (generator)	490	12	56	—	100 per cent overload momentarily
B.B.C.	3800 (motor)	475/535	18	73	29	Wind tunnel duty; 20 min overload of 5500kW

three-phase motors, or as single-phase motors alone or as phase convertors feeding the three-phase motors. The one-to-three-phase machines have a normally wound three-phase stator and rotor, but are equipped with an "inter-rotor" carried in bearings on the main shaft and not mechanically coupled to the shaft. This inter-rotor has a steel squirrel-cage winding and a d.c. excited distributed winding. There are thus two air gaps in the machine, one of 1·5mm and the other of 2mm. The railway authorities report mechanical troubles with these machines. The one-to-three-phase motors weigh 3300kg, equivalent to 6·6kg per kilowatt of one-hour rating, and the three-phase motors weigh 1600kg, equivalent to 3·2kg per kilowatt of one-hour rating.

Switchgear

The German switchgear industry made little progress of fundamental importance during the 1939–45 war. German designs have, naturally, much of interest as regards detail,[5, 6, 7] and information obtained on German experience, in the design and operation of circuit breakers and other equipment for voltages higher than that of the British grid, also repays study.

The lay-out of German switchgear, especially indoor is, in general, less economical than that of British switchgear, the indoor switchgear arrangements prevalent in Germany in 1945 being about equivalent to those encountered in Britain more than twenty years earlier. Examination of the detailed design of German circuit breakers, isolating switches and bus-bars, reveals careful consideration from the point of view of economical manufacture and the use of substitute materials. Germany had used small-oil-volume and air-blast circuit breakers and two-post isolators to a far greater extent that had Britain.

Examination of a number of air-blast breakers in Germany indicates that there is little to be learnt from them about the rupture of arcs by air-blast, and it appears that research in Britain on the many difficult problems involved is well in advance of German practice. The Germans, by their somewhat earlier start in the production of commercial air-blast circuit breakers, have naturally gained considerable practical designing and field experience, and the details of design of multi-break heads, air-blast valves, operating mechanisms, and sequentially operated series-air-break switches and associated ice-breaking devices, together with details of air consumption and pressure and also of air drying methods, are well worth study.[6]

In the development of metal-clad switchgear Germany lags far behind this country, and has made no appreciable contribution to this important aid to compactness and safety.

The two most interesting developments in Germany are the development by the A.E.G. of the "hard gas" circuit breaker and "hard gas" isolator,[6, 7, 10] and the development of the five-break and eight-break air-blast circuit-breaker heads of Swiss (B.B.C.) origin.[5, 6, 7, 8] The former is stated to have a field of usefulness up to 20kV and to powers of 200MVA, and the latter to 110kV and 220kV respectively at 2500MVA.

In the field of arc rupturing technique at the highest voltage the most widely used circuit breaker is the S.S.W. "expansion" breaker[6, 7]; this is of neat streamlined design, in which material is used with considerable economy and skill. Several leading firms employ resistance switching.

Much work has been done in Germany in recent years on the possibility of 400-kV a.c. and d.c. transmission, and, while no difficulty was expected in developing a.c. circuit breakers for the purpose, the problem of d.c. rupture at this high voltage has so far remained unsolved.[6, 7, 9, 10, 11]

In the field of flameproof switchgear for use in inflammable atmospheres, the results of German research, so far as it has gone, support results obtained in this country[12, 13]: Britain is, however, well ahead of Germany in this important branch of circuit breaking.

There is little to be learnt from the Germans on the subject of low-voltage fusible cut-outs and cartridge fuses.

German manufacturers were well served by the German porcelain industry,[6, 10, 14, 15, 16, 17] whose special bushings and other products have enabled their designers of switchgear and associated equipment to arrive at many neat constructional solutions, some of which are highly economical in the use of oil and metal.

There is evidence of a high degree of standardisation reached by the leading manufacturers and of considerable ingenuity in the economic use of materials, in the design of operating mechanism and in utilisation of special insulators and bushings, thereby effecting great economies in metal and oil.

A method for co-ordination of the design and lay-out of switching stations and their line diagrams has been developed by A.E.G.[19, 20]. The method calls for the preparation of a range of detailed circuit diagrams, assembled in book form, which facilitates the selection and application of any combination of individual units to meet the specified requirements for a complete installation.

A preliminary survey has been made of the possibility of applying a simplified type of circuit diagram to British practice.[18]

Transmission

On the whole, German practice with regard to the national high-voltage transmission system lags far behind British. There is little genuine and complete interconnection between power systems in Germany, whereas all the British grid transmission system functions continuously as a unit. On the other hand, Germany has an extensive 220-kV overhead line system which dates back to 1925. In general, the lines are less economical than British ones in respect of weight of material for a given current-carrying capacity and length, but some features have been introduced in recent years which show that German technicians are progressing in this respect. A novel German contribution to transmission line tower design is the hinged cross arm, a departure which has not commended itself to British engineers.

The Germans pioneered the hollow conductor in anticipation of transmission voltages of the order of 400kV, but abandoned it in favour of the "Bundel" conductor. They have done more investigation work on the subject of corona losses in overhead line conductors than any other nation, but have not brought their conclusions to a stage acceptable to British engineers, although the "Bundel" conductor is being examined with care for possible application here.

Germany has also pioneered in high-voltage d.c. transmission and has gone further than any other country in the commercial application of high-voltage d.c. The first system, that of Professor Marx, using air-blast rectifiers, has given place to an A.E.G./S.S.W. system using mercury-arc rectifiers. This may be the most important of all modern departures from established practice. Britain has an adequate background of experience in Highfield-Calverley experiments and in high-voltage mercury rectifiers for radio purposes to enable manufacturers to undertake high-voltage d.c. transmission should the need arise.

Germany started to develop centralised control of a power system during the war, but the control methods and equipment were primitive compared with those which have been available in Britain since the grid was put into operation. Germany has, however, much more widespread experience of carrier current telephony as applied to power lines. This is a result of the form of the German system, in which distances between generating stations and supply centres are great, rather than due to our manufacturers lagging technically.

High-Voltage Transmission Research

An investigation was carried out in 1941, at the direction of the German Office for Economic Development, to determine the limits of a.c. and d.c. transmission by cable and overhead lines over long distances. Six methods of power transmission were examined from the technical and economic viewpoints.

The voltages considered were 220kV and 400kV a.c. and 400kV, 650kV and 800kV d.c., and a substantial amount of information was obtained. The technical data are considered interesting and authoritative, but the conclusions regarding the efficiency and economy of a.c. and d.c. systems are in conflict with other authorities.

In 1943 the German Government decided to drop the schemes, which had been contemplated for the use of 400kV a.c. and to increase work, then already in hand, on plans for 400kV d.c. and considerable full-scale experimental work was carried out.[6, 7, 9, 10, 11]

Two major experiments in h.v. d.c. transmission were in progress in Germany during the war, but both were interrupted by destruction of plant before their objects were achieved. These two experiments comprised (*a*) the work of Professor Marx, and (*b*) the projected Berlin–Elbe transmission system by A.E.G. and S.S.W. Professor Marx was engaged in the construction of a 300-kV transmission system based on the use of his well-known gas blast type rectifier, which had been under continuous development for something like fifteen years. Throughout this period contact erosion had been a major problem and no satisfactory solution had been found. It was proposed to circumvent the issue by installing standby rectifier units, which could be switched into service to permit replacement of eroded electrodes as required. The working life of electrodes was expected to be of the order of three to six weeks.

The Berlin–Elbe system, comprising 70 miles of underground cable, a rectifier sub-station and an invertor sub-station, was to have employed two types of rectifier, one by A.E.G. and the other by S.S.W. Both were to have been of the single-anode excitron type, i.e., having a continuously burning excitation arc and an insulated cathode. The tubes were to be used in Graetz connection. The S.S.W. rectifier employed graphite anodes and grids, whilst the A.E.G. rectifier used iron anodes and grids. Provision was made in the S.S.W. rectifier for controlling the potentials of the upper grids by means of a capacity type potential divider, whilst the potential divider grids of the A.E.G. rectifier were to be left floating. In the case of the S.S.W. rectifiers, control grids were to have been supplied with a steep-fronted impulse and as a means of insulating the grid control gear from the individual rectifier cathode potentials, a high-frequency carrier modulated by the grid voltage wave form was to have been fed to the rectifier grids by capacity coupling.

The principles of design of these rectifiers had been tried out at lower voltages, notably in some experiments by S.S.W. on their rectifier on a small-scale transmission system at Charlottenburg, but the Berlin–Elbe equipment was destroyed before it was completely erected. No practical grounds exist therefore for a comparison of the two makes of rectifier.

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Industrial and Labour Notes

Britain's Overseas Trade

Provisional figures announced last week by the Secretary for Overseas Trade indicate that the value of United Kingdom goods exported during July was £141,500,000, which is £1,700,000 lower than the June total, and £9,900,000 less than in May. It is pointed out that July contained twenty-six working days—the same number as in May—whilst in June there were only twenty-four working days, so that the daily rate of export in July was 6·5 per cent lower than in May and 9 per cent lower than in June. Moreover, the Secretary for Overseas Trade has stated that owing to diversions to other ports, it has not been possible to estimate the effect of the London dock strike on the July export total.

There was, however, a reduction in the total value of goods imported into the United Kingdom during July, the provisional figure given being £186,500,000, which is £15,200,000 less than the record figure for June. With the exception of February, imports in July were the lowest this year. Re-exports during July are said to have been valued at approximately £4,300,000. The excess of imports over total exports was about £40,700,000, compared with £54,200,000 in June and £37,800,000 in May.

Non-Ferrous Metal Prices

The Ministry of Supply has announced that, as from Monday last, August 15th, the price of virgin aluminium in ingot form is increased from £90 to £93 per long ton, delivered to consumers' works, with the addition of £2 10s. per ton for metal in notch bar form. It is stated that the new price applies to metal of a purity of 99 per cent to 99·5 per cent, inclusive, and that the existing premiums for higher purities are payable in addition as follows: minimum purity, 99·6 per cent, £8 per ton; 99·7 per cent, £12; 99·8 per cent, £17; 99·9 per cent, £50; and 99·99 per cent, £100. The increased price, it is explained, is brought about by a rise in the average cost of current supplies.

Another price increase announced recently is that of good soft pig lead which, on August 9th, was raised to £87 5s. per ton delivered. On the other hand, there has been a reduction of 10s. a ton in the price of Baluchistan chrome. The price now ruling is £11 1s. 9d. per ton delivered ex ship, and £11 17s. per ton for deliveries ex store. The Ministry of Supply says that these prices include carriage charges to rail points nearest to consumers' works.

Iron and Steel Prices

The Minister of Supply has made a new order—Control of Iron and Steel (No. 73) Order, 1949—which authorises some price changes in certain iron and steel products.

Among the alterations are a reduction of 67s. 6d. a ton in the price of galvanised sheets and of 13s. 4d. per ton in the price of terneplates. Other reductions include tubes, wire nails, alloy steel black bars, and alloy steel wire rods. The price of bright bars, however, has been increased by 8s. 3d. a ton. A few other minor alterations are authorised by the Order, and the relevant deposited schedules are available at Steel House, Tothill Street, London, S.W.1.

The Order became effective on August 16th.

A "Crisis of Reserves"

Commenting on current economic affairs, in his chairman's address at the recent annual meeting of Edgar Allen and Co., Ltd., Mr. W. H. Higginbotham referred to the so-called "crisis of reserves." It had been disclosed suddenly, he said, almost as if it were an unforeseeable, inescapable and undeserved natural phenomenon, and had been described as "either grave and menacing or troublesome, but capable of fairly easy solution." But the sole remedy as yet proposed by the Government was a substantial cut in dollar imports, with admittedly serious consequences to our trade and employment. Informed opinion, Mr. Higginbotham continued, was that that was quite inadequate to the gravity of the case, but that no other measures were, as yet, in sight. The crisis was not, in fact, unforeseeable—it was a recurrence or prolongation of that of 1947—and to say, as some did, that since the U.S.A. had caused it, that country must resolve it, was to ignore our own undeniable share in its creation.

Mr. Higginbotham went on to say that since the end of the war our credit abroad had declined grievously and that disunity was fostered and widespread at home. Though money wages had increased and so-called "free" social services had expanded, so also had industrial discontent. The trades unions, riven by internal dissension and indiscipline, largely due to ineffective leadership and undemocratic practice, were in danger of disruption. Massive American aid alone, Mr. Higginbotham contended, had averted massive unemployment, with a consequential loss of wages of the order of £400,000,000 a year and widespread suffering. The plain, hard and irrefutable fact, he observed, was that we had been trying to attain and to maintain a standard of living to which our efforts had not entitled us, and we could not continue except by very much harder work without additional reward. The people of this country, having been led for so long to believe the opposite, must now be told—and what was more, must be persuaded to accept—that bitter truth, or otherwise they would lose much of what they had gained over many years. The Government, Mr. Higginbotham concluded, hampered by its dependence on trade unionism, devoted to sectional rather than wider national interests, obsessed by economic doctrine of at least doubtful validity, and inhibited by its commitments and past pronouncements, had realised this truth too late. Its efforts to bring it home to the mass of the people had been half-hearted, unconvincing and ineffective.

Railway Shopmen's Wages

In the early part of this week representatives of the Confederation of Shipbuilding and Engineering Unions had a discussion with the Minister of Labour, Mr. Isaacs, concerning the Conciliation Board, which has been appointed to examine the wages of railway shopmen. It is understood that the Confederation has not accepted the Minister's invitation to participate in the Board's deliberations, and that the reasons for the refusal have now been put before the Minister. The Confederation has already explained that it is not a party to the claim for an all-round wage increase of 10s. a week advanced by the National Union of Railwaymen, as it holds the view that the claim is prejudicial to the differential rates paid to craftsmen in railway workshops. As we go to press it is learned that the position of railway shopmen's wages is to be further considered by the Confederation's council at its quarterly meeting, which is taking place in York this week.

Employment and Unemployment

The Ministry of Labour's latest survey of Great Britain's manpower situation shows that during June the working population declined by 16,000 (all men) and, at the end of the month, totalled 23,193,000 (16,023,000 men and 7,170,000 women). The number in civil employment, however, increased during the month by 9000 men and 12,000 women to a total of 22,157,000.

The number of people employed in the basic industries of the country increased during June by 8000, but as the principal additions were in agriculture and transport, they must be regarded in some measure as seasonal changes. The downward trend in coalmining manpower continued during June, when there was a further decline of 1000. At the end of the month the number on colliery books was 722,000, compared with 726,000 at the end of 1948. In the manufacturing industries the total number of people employed in June was 8,252,000, a figure 5000 below that for the preceding month. In this classification the principal change was in the "metals, engineering and vehicles" industries, which reported a decrease of 12,000, the total at the end of the month being 3,900,000. Other changes reported in June were an increase of 7000 in the number of people employed in building and contracting, bringing the total to 1,489,000, and an addition of 14,000 to the number engaged in "professional, financial and miscellaneous services." The total in that category was thereby increased to 3,927,000.

Unemployment returns published this week by the Ministry of Labour record that on July 11th there were 243,041 people registered as out of work, compared with 263,643 a month earlier.

The British Institute of Management

The British Institute of Management has now been in existence for nearly two years and among its recent publications is a pamphlet entitled "Service for Management," which contains a useful summary of the work upon which the organisation is now engaged. The pamphlet emphasises that if management problems are to be tackled successfully, the time has come to pool ideas in a "big way." The Institute's information service is now acting as a clearing house or pool for such knowledge, and the intention is that it shall become the most comprehensive information centre on management practices throughout the world.

Although the Institute is not a teaching body, it naturally devotes a good deal of attention to the promotion of facilities for education and training for management at all levels. Jointly with the Ministry of Education, it is sponsoring a scheme of part-time courses for management studies on a national basis. These courses, it may be mentioned, lead to certificates which several specialist Institutions have arranged to accept as equivalent to their own professional examinations. In addition, the Institute is also discussing with university authorities the possibility of increased facilities for management training, and is also developing schemes for the training of foremen and supervisors.

In detailing its activities, the Institute makes it clear that one of its main functions is to stimulate widespread interest in better management, and to develop management towards the status of a profession. This latter, the Institute regards as a long-term task, but the pamphlet states that it is not intended to award professional qualifications until satisfactory standards and tests have been evolved.

Industrial Safety Conference

The Industrial Safety Division of the Royal Society for the Prevention of Accidents is arranging another residential conference, which is to be held at the Royal Hotel, Scarborough, on Friday, Saturday and Sunday, October 7th, 8th and 9th. The subjects for discussion include the safe use of solvents, the installation and maintenance of breathing apparatus, and the use of electrical apparatus in hazardous atmospheres, and although the programme is intended mainly for the chemical industry, it is being arranged to provide matters of interest to other industries also.

The fee for the conference, including accommodation, will be £5. Application forms can be obtained from the Secretary of the Society, 131, Sloane Street, London, S.W.1.

French Engineering News

(From our French Correspondent)

Repercussions are still resulting from the reduction of credits to the S.N.C.F. Many ancillary industries have been affected by the curtailment. A reduction of 1 milliard francs has been made on track renewals and 2 milliard on reconstruction work. The timber industries have had an order for 25,000 telegraph poles (representing 50 million francs) postponed, and an order for 250,000 spans (valued at 250 million francs) cancelled. Similarly affected are the textile industries, rolling stock manufacturers and repairers, and constructors of fixed railway installations.

Large-scale unemployment may follow the measure. At the Aciéries du Nord, at Hautmont, which specialises in locomotive repairs, reduced work has brought the number of hours worked each month from 150,000 to 63,000 and 450 workers may be discharged. Other factories have had orders spread over a longer period so that at Baume-Marpent seven trucks are being constructed daily instead of twelve, with the working week reduced from forty-eight to forty hours. The Mechanical Industries Syndicate also states that it has been affected, but here the position is paradoxical: the Ardennes metal fixtures manufacturers, who are equipped to supply 20,000 fixtures annually, have been asked by the Government to increase production capacity to 25,000, yet over the last five years the industry has received orders corresponding to less than 15,000 trucks and now the S.N.C.F. reductions will reduce turnover from the 92 million francs envisaged up to December 31st to 7 million francs.

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There is no doubt that a good deal of the S.N.C.F. deficit comes from the fact that tariffs are lower than the normal. Other causes are given as the increase in taxes, which amounted to 29 milliard francs in 1949, the cost of exploiting suburban lines, which cost almost 8 milliard francs annually, and the steep reduction in traffic, amounting to 20 per cent in June. Monsieur Tissier, President of the S.N.C.F. Administrative Council, rejects the idea that the 40,000km of secondary lines prove a large factor in the deficit. The economy resulting from their suppression, he says, will be cancelled out by subsidies to other forms of transport. On the other hand, the objects of the Monnet Plan are now considered too ambitious and the S.N.C.F. has done well to reduce certain programmes 40 per cent. However, the task is still far from accomplished. There remain 369 bridges, 125 overhead passages, 400 stations, and 50 per cent of the depots to be reconstructed. Against this, improved output is reducing costs, trucks are loaded more fully than before, enabling the construction of many thousands to be avoided. Coal consumption is going down.

In 1949, the S.N.C.F. will receive 70 milliard 500 million francs for re-equipment, which will enable reconstruction to be carried out up to 60 per cent of that needed. Of this total 11 milliard 600 million will be used for rolling stock, and 8 milliard 120 million for indemnities, which will cover only a part of the 12 milliard carried by the S.N.C.F. for reduced tariffs and other privileges. The electrification of lines will be suspended as well as modernisation of fixed installations, replacement of rails and other maintenance work, while orders for rolling stock will be postponed or cancelled.

On the other hand, the slowing down of orders to constructors and repairers does not stop them from pursuing research on the construction of new materials and the application of electric welding is being seriously studied, and pressed steel fittings are replacing castings to a considerable extent.

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A new Franco-Italian commercial agreement envisages exchanges between the two countries to the value of 18 milliard francs. French exports will include agricultural material, iron ore, phosphates, food, mechanical and chemical products. Italy will send ore and metals including 25,000 tons of zinc, mechanical products, electrical equipment, nitrogen fertilisers, agricultural and food products.

Notes and Memoranda

Rail and Road

PROPOSED TRANS-ANDES ROAD.—It is reported that plans are now being studied for the construction of a road across the Andes between Argentina and Chile. The project, it is stated, envisages the cutting of the road from San Juan to Coquimbo via Agua Negra.

SLOANE SQUARE STATION.—Preliminary work has now been started on the reconstruction of Sloane Square underground station, London, which was virtually destroyed by a bomb in 1940. London Transport states that the present works are limited to clearing the site of the original station and involve the removal of the temporary ticket-hall and stairs which have served since the bombing. A new temporary entrance and ticket-hall have been opened in Holbein Place and are linked to the platforms by means of staircases from a new footbridge over the tracks. The bombed station, which had been rebuilt only a few months before its destruction, incorporated escalators direct from the platforms to street level, an innovation so far as London underground stations were concerned. When the station is rebuilt the intention is to restore this facility.

LOCOMOTIVES FROM MIDDLE EAST.—In 1947 the Railway Executive Committee was notified of certain War Department locomotives which were surplus to requirements in the Middle East, and arrangements were made for an inspector from the Chief Mechanical Engineer's Department, London Midland Region of British Railways, to examine them in their various locations to ascertain how many were in a suitable condition for further work in this country. As a result of this inspection, arrangements were made for thirty-nine class "8" 2–8–0 freight tender locomotives and four spare 4000-gallon tenders to be returned to this country. The London Midland Region says that they are now undergoing repairs at Crewe prior to taking up duty, the first of the locomotives—"No. 48,045"—being already in service. Ten of the locomotives were originally in L.M.S. stock and formed part of a total of fifty-one locomotives of this type which were sold to the Ministry of Supply in the early war years. The remainder of the locomotives returned were built to L.M.S. designs by private firms and purchased direct by the Ministry of Supply.

Miscellanea

THE LATE MR. J. MCKECHNIE.—We have learned with regret of the death, on August 5th, of Mr. John McKechnie, secretary of the Mirrlees Watson Company, Ltd., Glasgow. Mr. McKechnie joined the staff of the company in April, 1906, and had been secretary since 1931.

EXPERIMENTAL STRESS ANALYSIS.—The Society for Experimental Stress Analysis is to hold its annual meeting at Hotel New Yorker, New York, on November 30th and December 1st and 2nd next. Full details can be obtained from the Society at P.O. Box 168, Cambridge 39, Mass, U.S.A.

AN AMERICAN OIL PIPE-LINE.—A Reuter report states that contracts have been awarded for the construction of a 1000-mile crude oil pipe-line from Texas to Ohio. It is understood that the pipe-line will originate near Longview, Texas, and will be laid in a north-easterly direction to Lima, Ohio.

STEELWORKS EQUIPMENT EXHIBITION. — An exhibition of iron and steelworks equipment was staged recently by Head, Wrightson and Co., Ltd., at its works at Thornaby-on-Tees. It included examples of many of the items now being manufactured by the firm, all of which were demonstrated by members of the company's technical staff.

GALVANISED TANK PRICES.—Following a decrease in the cost of raw materials, the Ministry of Works has confirmed a reduction equivalent to 2½ per cent of the basic list prices of galvanised tanks and cisterns manufactured by members of the Galvanised Tank Manufacturers' Association. In accordance with the Association's revised discount scheme the new "plusage" will be 52½ per cent on basic list prices. The revised maximum prices concern deliveries made on and after August 8th.

LECTURES ON SOIL MECHANICS.—The Midlands Association of the Institution of Civil Engineers, in collaboration with local branches of the Institution of Municipal Engineers and the Institution of Structural Engineers, and with the Ministry of Works, is making arrangements for a course of lectures on soil mechanics, to be delivered in Birmingham during the forthcoming session. It is hoped that the course, consisting of twelve lectures, will begin in October, and it is suggested that the lectures should be delivered on Wednesdays at 5.30 p.m. The lectures are to be accompanied by experiments conducted in the laboratory of the City Council's Public Works Department, Brasshouse Passage, Birmingham. The charge for the full course will be two guineas, and application for enrolment should be made to Mr. T. P. Veal, 160, Ravenhurst Road, Birmingham, 17.

INDIA'S STEEL INDUSTRY.—It is reported that consultants appointed by the Government of India to advise on the provision of new steel plants have recommended that one of the plants should be in the Central Provinces and another in Orissa. It is estimated that the capital cost of one of the plants is likely to be between 500,000,000 and 600,000,000 rupees, and that an annual production of from 500,000 to 600,000 tons of steel may be expected when the plant is complete in about five years' time.

EXHIBITION OF MACHINE TOOLS.—Alfred Herbert, Ltd., announces that it will hold an exhibition of machine tools and equipment in the showroom at Montrose Avenue, Hillington, Glasgow, from September 1st to 17th inclusive. A number of Herbert and Edgwick machines, together with Archdale radial and upright drilling machines and milling machines will be shown in operation, and there will also be an extensive display of small tools and measuring equipment. The exhibition will be open daily from 9.30 a.m. to 6 p.m.

SWISS MACHINE TOOLS.—We have received an interesting publication entitled "Machine Tools at the Swiss Industries Fair," which has been compiled and issued by the organisers of the industrial fair recently held at Basle. The book deals in some detail with the many and varied types of machine tools exhibited by Swiss manufacturers and provides an interesting survey of this important industry. The machines are classified under their various types, illustrated, and described in a clear, concise manner. We understand that copies of this book can be obtained by those interested from the Swiss Legation, 18, Montague Place, London, W.1.

ELECTRONICS SYMPOSIUM.—The Scientific Instrument Manufacturers' Association of Great Britain, Ltd., is arranging its second "Electronics Symposium," to be held on Wednesday, Thursday and Friday, November 2nd, 3rd and 4th at the Examination Hall, Queen's Square, London, W.C.1. On the first day the proceedings will begin at 2.30 p.m., and on the two succeeding days at 10 a.m. The papers to be presented are: "Electronic Instrumentation in Atomic Research," by Dr. Dennis Taylor; "Electronic Amplifiers," by Mr. Blackman; "Magnetic Amplifiers," by Mr. A. V. Hemingway; "Some Recent Improvements in Electronic Measuring Techniques," by Mr. C. H. W. Brookes-Smith and Mr. J. A. Colls; "The Measurement of Transient Phenomena," by Dr. H. A. Dell; "An Industrial Electronic Servo-Mechanism," by Mr. P. H. Briggs, and "Co-operative Research at B.S.I.R.A.," by Dr. A. J. Maddock. Mr. A. G. D. West will sum up the proceedings on November 4th at 12.30 p.m. A comprehensive display of the latest types of British scientific and electronic instruments will be demonstrated during the period of the meetings. Tickets for the symposium can be obtained from the secretary of the Association at 17, Princes Gate, London, S.W.7.

INTERNATIONAL SCIENTIFIC FILM ASSOCIATION.—The third International Scientific Film Congress is to be held in Brussels from September 30th to October 5th next. Delegations from many countries will meet to discuss progress on various subjects of importance in relation to the international aspect of scientific films, and reports will be presented on such projects as the establishment of a standard method for cataloguing and recording information about scientific films and on customs regulations in relation to the international exchange of scientific films. In conjunction with the congress there will be a scientific film festival, which will include four public sessions with films dealing with research, education and scientific documentary. The fourth show will consist of general scientific films. In addition to the public shows there will be four sessions intended for specialists, the fields to be covered being research, education, industry and medicine. The Scientific Film Association of Great Britain is considering the films to be submitted as the British entry in the festival. Whilst the Association has knowledge of most of the major films, it would appreciate information regarding privately produced films which would be suitable for inclusion. Full details should be sent to the office of the Association at 4, Great Russell Street, London, W.C.1.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

British Society for International Bibliography

To-day, Aug. 19th.—British Standards Institution, 28, Victoria Street, S.W.1, extraordinary general meeting, 2.15 p.m.

Engineering and Marine Exhibition

Thurs., Aug. 25th, to Sat., Sept. 10th.—Olympia, London.

Incorporated Plant Engineers

Fri., Sept. 2nd.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, "The Preparation of Granite for Roads," C. G. Kitchingman, 7.30 p.m.

Institute of the Motor Industry

Sat., Aug. 27th, to Sat., Sept. 10th.—St. Catherine's College, Cambridge, third annual summer school.

Institution of Naval Architects

Tues., Aug. 30th, to Fri., Sept. 2nd.—Autumn meeting, Copenhagen.

Institution of Production Engineers

Sat., Sept. 3rd.—BIRMINGHAM GRADUATE SECTION: The University, Bristol Road, Birmingham, Graduates' Conference on "Training and Leadership in Production Engineering," 9.15 a.m. to 5.30 p.m.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1.

TENSIONAL STEEL STRAPPING

No. 1133: Section 15. This code, which was originally prepared to assist the Services in dealing with their packaging problems, has in practice been widely used by industry. The British Standards Institution has for some time been engaged on a revision of this code, and Section 15 deals with tensional steel strapping. The new section gives guidance on the use of tensional steel strapping for all types of containers and packages. Further sections will be issued from time to time; a substantial part is expected to be available in the early autumn. Price 2s. post free.

HIGHLAND ELECTRICITY SUPPLY.—Electricity was recently brought to Tomintoul, Banffshire, the highest village in the Scottish Highlands, by the North of Scotland Hydro-Electric Board. To provide this supply the Board had to construct one of the highest distribution lines in Britain. This line is an extension from the existing 11,000V Ballindalloch-Minmore h.t. line in Glen Livet. It runs at this pressure to a point close to the village and is then transformed to 415/240V. The h.t. line is approximately 8½ miles in length and had to be erected over moor, rock and peat, at an average height of 1250ft. above sea level. To withstand the severe weather conditions which prevail in the area, distribution poles had to be specially strengthened by additional side stays and many of the poles had to be fitted with bog shoes. The work on the line and on the erection of the poles was carried out by Balfour Beatty, Ltd.

DESIGN OF WELDED FRAMES.—A recent revised British Standard (No. 449) permits welded rigid frames to be designed on load-carrying capacity, but until recently little information was available about the actual performance of these frames under load. Any acceptable design method must be based on the fullest knowledge possible and the British Welding Research Association has for some years been supporting a comprehensive investigation carried out in the Engineering Department at the University of Cambridge. The research work is said to have resulted in a theory which takes into account both the elastic and plastic properties of steel, and enables a satisfactorily accurate estimation to be made of the load which can be placed on the structure before it collapses. Exhaustive tests have been made of the design methods based on the theory; at Cambridge miniature frames and full-scale rectangular portals have been loaded to the point of collapse, while measurements have been taken of the stresses and strains produced. The results, it is claimed, have confirmed the theory and shown that the new methods of design will save steel and reduce the cost of welded steel structures by a considerable amount.

Personal and Business

MR. V. R. PREHN, M.I.P.E., has been appointed a director of Ruston-Bucyrus, Ltd.

MR. F. R. M. DE PAULA has been appointed a director of the Brush Electrical Engineering Company, Ltd.

MR. C. F. WATTS has been appointed secretary, and Mr. W. V. Hodgson, general manager, machine tool division, of A. C. Wickman, Ltd.

THE CANADIAN PACIFIC RAILWAY announces the appointment of Mr. H. W. Hayward as engineer of standards and methods, with headquarters at Montreal.

MR. J. R. LAMBERTON has been appointed a director of the Mirrlees Watson Company, Ltd. Mr. J. M. Lauder has been appointed secretary of the company.

MAJOR H. E. ALDINGTON, M.I.C.E., who has recently retired from the post of Chief Engineer of the Roads Department, Ministry of Transport, is joining the board of the Amalgamated Roadstone Corporation, Ltd.

STERLING METALS, Ltd., Coventry, announces the retirement of Mr. H. Williams, who has been a director and secretary of the company for twenty-nine years. Mr. T. Barker has been appointed secretary.

THE RAILWAY EXECUTIVE announces the following appointments:—Mr. T. M. Herbert, Director of Research; Mr. T. W. Brown, Materials Inspection Officer; and Mr. G. M. Leach, Assistant to Chief Officer (Continental).

W. H. WILLCOX AND CO., Ltd., Southwark Street, London, S.E.1, has been appointed sole distributor for England, Scotland and Wales of the Burston cam spanner manufactured by Charles Richards and Sons, Ltd., Darlaston.

DOWDING AND DOLL, Ltd., states that it has appointed John S. Young and Co., Ltd., 257–261, Eglinton Street, Glasgow, C.5, as sole distributor in Scotland for its British-made machines and sub-agents for imported American and Swiss equipment.

CYC-ARC, Ltd., 27–29, New North Road, London, N.1, makers of stud welding equipment, has made arrangements with Buehrle and Co., Zurich-Oerlikon, Switzerland, appointing this firm licensee for the manufacture and sale of Cyc-Arc products in some twenty countries.

MR. R. L. CHANTNILL has been appointed chief technical engineer of the British Thomson-Houston Export Company, Ltd. He has recently returned to this country from India, where for some years he has been director and chief engineer of Associated Electrical Industires (India), Ltd.

CAPTAIN T. H. THORNEYCROFT has tendered his resignation from the office of Deputy Chairman of the Scottish Divisional Coal Board, in order to take up an appointment outside the coal industry. At the invitation of the National Coal Board, he has consented to remain on the divisional board, until the end of the year, as a part-time director.

MR. R. G. BURT, M.I. Mech. E., and Mr. C. C. Bates have joined the technical liaison staff of the British Welding Research Association. Mr. J. G. Ball has left the staff of the Association to become principal scientific officer at the Ministry of Supply's Atomic Energy Research Station, Harwell, and Mr. A. Barker is relinquishing the secretaryship of the Association at the end of the month to take up an appointment as assistant director of the Federation of Boot and Shoe Manufacturers.

Catalogues

ELECTRIC CONSTRUCTION COMPANY, Ltd., Bushbury Engineering Works, Wolverhampton.—Illustrated catalogue entitled "More Efficient Plating."

STURTEVANT ENGINEERING COMPANY, Ltd., Southern House, Cannon Street, London, E.C.4.—Publication number 9801 entitled "Lime Hydrating."

LUSHINGTON TOOL MANUFACTURING COMPANY, Ltd., South Road, Hailsham, Sussex.—Booklet dealing with precision tools and instruments, and price list.

GOODMANS INDUSTRIES, LTD., Lancelot Road, Wembley, Middlesex.—Folder describing the 12in 20W high fidelity reproducer, the "Axiom 22."

ALUMINIUM WIRE AND CABLE COMPANY, Ltd., 10, Buckingham Place, Westminster, London, S.W.1.—Brochure describing the activities of the company.

MULLARD ELECTRONIC PRODUCTS, Ltd., Aboyne Works, Aboyne Road, London, S.W.17.—Folder dealing with Mullard instruments for research and industry.

F. BURNERD AND CO., Ltd., Government Buildings, Kidbrooke Park Road, Kidbrooke, London, S.E.3.—Catalogue number 38, featuring precision lathe chucks.

JAMES ARCHDALE AND CO., Ltd., Ledsam Street, Birmingham, 16.—Catalogue illustrating and describing heavy-duty hydraulic control radial drilling machines.

ALUMINIUM DEVELOPMENT ASSOCIATION, 33, Grosvenor Street, London, W.1.—"Aluminium and Aluminium Alloy Electrical Conduit and Fittings: Notes for Users."

FIRTH BROWN TOOLS, Ltd., Sheffield.—Publication number 156, "Sharpening Machine for Circular Saws"; publication number 153, "Type 3 Face Milling Cutter."

AUTOMATIC TELEPHONE AND ELECTRIC COMPANY, Ltd., Strowger Works, Liverpool, 7.—Publication number 1116, illustrating "Intercom" telephone systems.

FISHER AND LUDLOW, Ltd., Bordesley Works, Clyde Street, Birmingham, 12.—Booklet entitled "Survey of Material Handling," leaflet describing "Flowchair," industrial seating.

ELECTRICAL POWER ENGINEERING COMPANY (B'HAM), Ltd., 421, Grand Buildings, Trafalgar Square, London, W.C.2.—List RI-149, giving particulars of repulsion induction motors from ¼ h.p. to 3 h.p.

MORGAN CRUCIBLE COMPANY, Ltd., Battersea Works, Battersea Church Road, London, S.W.11.—Folder illustrating the Morgan trolleybus current collection insert, and a catalogue of Morganite brush holders.

HACKBRIDGE AND HEWITTIC ELECTRIC COMPANY, Ltd., Hersham, Walton-on-Thames, Surrey.—Publication number R.222 entitled "Hewittic Rectifiers for D.C. Supply to Steel Mills and Engineering Works."

RANSOMES AND RAPIER, Ltd., 32, Victoria Street, London, S.W.1.—Folder illustrating the "5 NT" and "7 NT" trailer mixers, and booklets describing the 8½ ton "Super Mobile" crane, and the Rapier range of mobile cranes.

GENERAL ELECTRIC COMPANY, Ltd., Magnet House, Kingsway, London, W.C.2.—Booklet describing the 1949/50 range of G.E.C. television receivers, and leaflets entitled "Electric Sterilising Chests for Dairies," and "Electric Steam Raisers."

POWER-GAS CORPORATION, Ltd., Parkfield Works, Stockton-on-Tees.—Brochure describing "P.G. Oil Refining and Hardening Plant," reference number O.R.H. 549, and booklet dealing with dust and fume control and recovery equipment.

MARCONI'S WIRELESS TELEGRAPH COMPANY, Ltd., Marconi House, Chelmsford.—Leaflets Nos. SL 301, "Aircraft Equipment Tester"; SL 302, "Beacon Type WB 8"; SL 101, "V.H.F. Multi-Channel Communication"; SP 8/3, "Receiving and Rectifying Valves"; SP 7/3, "Transmitting and Power Rectifying Valves"; D 19, "Type U 19."

NUFFIELD FELLOWSHIPS IN EXTRACTION METALLURGY.—During the year 1950 the Nuffield Foundation is offering a limited number of fellowships and scholarships with the object of advancing research and training in extraction metallurgy. Citizens of Great Britain, the Commonwealth and Empire are eligible to apply. The offer includes: travelling fellowships, which are open to men who are members of the teaching staff of universities and approved schools of mines and metallurgy; travelling post-graduate scholarships, open to junior members of the profession who are graduates of universities and approved schools of mines and metallurgy; and vacation scholarships, open to mining and metallurgical students at universities and approved schools of mines and metallurgy. Applications for fellowships and scholarships to be taken up in 1950 must be received before November 1, 1949, by the Secretary, Nuffield Foundation, 12 and 13, Mecklenburgh Square, London, W.C.1, from whom full particulars and application forms can be obtained.

CINE-PHOTOGRAPHY UNDER THE SEA.—Following experimental work in the Mediterranean in 1948, methods have now been developed by the Admiralty for taking cine films under the sea in normal daylight illumination and by artificial light at night. A "frog-man" diver wearing a self-contained air breathing set swims in perfect freedom with the camera at depths of 100ft. The cameras, which are electrically driven, are powered by portable batteries in the watertight cases in which they are enclosed, and the aperture and focusing controls can be adjusted whilst actually swimming towards the subject being filmed. The experiments in the Mediterranean last year determined quantitatively the distance at which photography was possible for different conditions of water clarity, object tone, sunlight angle, working depth and exposure. Different monochrome and colour emulsions were used. In the clearest conditions of all, objects up to 30ft away were sharply recorded. Artificial light projectors were specially designed for use on the sea bed, and the methods have been applied for wreck survey in damage and salvage investigations, marine life studies, sea bed topography and propeller performance. Slow-motion films have also been made of the discharge of torpedoes from a submarine whilst in action. A research film (35mm, sound, 20 mins.) summarising the results has been made and is being edited by the Crown Film Unit for issue by the Central Office of Information in September entitled "Wonders of the Deep." The development has been the work of three men at the Admiralty Research Laboratory, Mr. W. Deryck Chesterman, a physicist; Mr. John B. Collins, an engineer, and Mr. H. James Hodges, the specialist diving cameraman. Investigations are being continued in the Royal Naval Scientific Service on behalf of the Director of Boom Defence and other Admiralty Departments.

A Seven-Day Journal

British Thomson-Houston Appointments

It is announced by the British Thomson-Houston Company, Ltd., of Rugby, that Mr. A. A. Pollock, B.Sc., director and chief mechanical engineer, has retired, but will be available in a consultative capacity, and that Mr. K. R. Hopkirk, M.A., has been appointed to succeed him as chief mechanical engineer. Mr. Pollock was born in 1882 and graduated at the Royal College of Science, Dublin, his native city. After gaining practical experience, he joined the B.T-H. Company in 1902, entering the d.c. engineering department, and in 1910 he was appointed head of that department. In July, 1945, he was appointed chief mechanical engineer, and in March, 1946, was elected a director of the company. Mr. Pollock was closely associated with the shop technique of commutator building, and is the designer of the recently introduced "Pollock" commutator. He took a leading part in rolling mill motor design, and the electric propulsion of British ships, and during the recent war was responsible for the design and manufacturing technique of electric torpedoes. Mr. Pollock's department also developed the "controlled current" system, a forerunner of the modern "Amplidyne" control. He visited the G.E.C. works in America to study factory methods on several occasions. Mr. Hopkirk graduated at Emmanuel College, Cambridge, and joined the B.T-H. Company in 1915, and in 1919 he was given charge of the testing of turbines. In 1920 he joined the design staff of the turbo-generator department, and became the chief of that department in 1939. In July, 1945, he was appointed assistant chief mechanical engineer of the company. Throughout his B.T-H. career Mr. Hopkirk has been closely associated with the mechanical and electrical problems connected with the design and construction of turbo-alternators, and he is the inventor of the new type of B.T-H. turbo-alternator rotor winding. Concurrent with Mr. Hopkirks' appointment as chief mechanical engineer, other changes have been made. The plant engineering department, under the management of Mr. Anscombe, M.A., M.I.E.E., now deals with the design of large a.c. and d.c. machines, excluding turbo-alternators, while the motor engineering department, under the management of Mr. B. Pringle, deals with the design of small a.c. and d.c. machines. The rectifier work has now been constituted a separate department, and Dr. J. C. Read, M.I.E.E., has been appointed its manager.

A United Kingdom–Canada Air Agreement

On Friday last, August 19th, there was signed in Ottawa a new air services agreement between the United Kingdom and Canada. The agreement was signed by the Hon. Lionel Chevrier, K.C., the Canadian Minister of Transport, and Sir Alexander Clutterbuck, K.C.M.G., the United Kingdom High Commissioner in Canada. The new agreement is of the Bermuda type, unlike previous agreements between the two countries, which it supersedes. The United Kingdom obtains five routes: through Gander, Newfoundland (now in Canadian territory), to New York, Bermuda and beyond; to Montreal via Gander; from the British Colonies in the Caribbean area and Bermuda to Montreal; across the Pacific, between Fiji and Vancouver; and to Hong Kong via Northern Canada, Alaska, the Aleutians, Japan and Shanghai. In exchange, the agreement gives Canada four routes: between Canada and the United Kingdom; from Canada via Bermuda or Tampa (Florida) to the British Colonies in the Caribbean area, and beyond to South America; from Vancouver through to Fiji, to Australia and New Zealand; and between Vancouver and Hong Kong. By an exchange of notes, the arrangement which was made in 1947 is continued, whereby the Canadian air line on the route between Canada and the British Colonies in the Caribbean area enjoys cabotage rights between Bermuda and the other British Colonies. By this exchange, also, the United Kingdom undertakes not to operate on its reciprocal route between Bermuda or the British Colonies in the Caribbean area and Montreal until January 1, 1951. As far as Bermuda and the Bahamas are concerned, the arrangement is subject to approval by their legislatures.

The German Iron and Steel Industry

It is announced by the Board of Trade that during this week-end a report on the ferrous metal industry in Germany, covering the period 1938 to 1945, will be published as a B.I.O.S. Overall Report No. 15, price 4s. 6d. at the Stationery Office. The authors of this report are Mr. George Patchin, formerly the Principal of the Sir John Cass Technical Institute, London, and Mr. Ernest Brewin, the Intelligence Officer of the British Iron and Steel Federation. It will be remembered that the German iron and steel plants were inspected between November, 1944, and May, 1947, by some 120 teams of British and American experts, each team issuing its own report. Already some 400 reports have been issued by the Stationery Office, and in the forthcoming volume these, and other reports, are correlated and condensed. The volume is in nine sections, covering blast-furnace plant and practice, steelworks plant and practice, mechanical treatment, foundry practice, steels, ferro-alloys and hard metals, heat-treatment, cutting, joining, repairing and fastening, coatings, including cladding and bonding, and research and testing. The volume also contains critical analyses and comparisons between pre-war and wartime practice, and deviations from British and American practice. Trends induced by material shortages or by the availability of new alternative materials or processes are recorded, and the possibility of future applications of wartime innovations is discussed. The research section shows the close link between German investigators and the industries concerned, and it surveys the iron and steel research centres, reviewing their specialised work. There is a comprehensive index and an appendix to each section, which gives a full reference to the original reports surveyed, and to other relevant German documents and reports.

Scientific Survey of North-Eastern England

In connection with the forthcoming meeting of the British Association for the Advancement of Science, which will be held from August 31st to September 7th at Newcastle-upon-Tyne, the Local Executive Committee, under the chairmanship of Lord Eustace Percy, has prepared a valuable scientific survey of North-Eastern England. The President of the British Association, Sir E. John Russell, contributes a Foreword, and there is an introduction by Professor G. H. J. Daysh, of King's College. There then follows a full account of the natural history of the region and its regional settlement from Roman to modern times. Of more interest to our readers will be the admirable section on the industries of the region. Professor G. Poole, M.I. Min. E., and Mr. A. Raistrick, F.G.S., both of King's College, Durham University, deal with the extractive industries which embrace not only the mining of coal and iron, but lead mining and the winning of barytes, witherite and fluorspar. The section on iron and steel is entrusted to Mr. H. Boot and Mr. T. F. Pearson, M.Sc., of the Consett Iron Company, Ltd., while shipbuilding is in the able hands of Mr. H. B. Robin Rowell, the chairman of R. and W. Hawthorn Leslie and Co., Ltd. The complementary subject of marine engineering is written by Mr. P. L. Jones, M.I.C.E., M.I. Mech. E., the general manager of the engineering department of Swan Hunter and Wigham Richardson, Ltd. Mechanical engineering finds an able exponent in Sir Claude Gibb, F.R.S., the managing director of C. A. Parsons and Co., Ltd., while Parsons' chief electrical engineer, Mr. W. D. Horsley, M.I.E.E., deals with electrical engineering. Civil engineering is described by Mr. J. M. Rounthwaite, B.Sc., M.I.C.E., a consulting civil engineer; and Mr. B. P. Hill, M.I. Chem. E., of Fisons, Ltd., and Dr. G. R. Clemo, of King's College, write on the chemical industry, including the making of bricks, glass and refractories. Professor Daysh contributes a section on other industries of the North-East. Agriculture is dealt with by Professor Pawson and the fishing industry by Professor Hobson. Finally, there is a section on Newcastle-upon-Tyne, the geographical setting being dealt with by Mr. M. R. G. Conzen, M.A., and the economic status of Newcastle by Mr. E. Allen, of the University of Durham.

"Pluto" Inventions Awards

It is announced that the Royal Commission on Awards to Inventors has recommended that tax-free awards totalling £15,100 should be granted to the four principal men whose inventions made possible the "Pluto" project for petrol pipe-lines under the English Channel. A full account of that remarkable work will be found in our 1945 volumes. Mr. A. C. Hartley has been recommended for an award of £9000 for his invention of the H.A.I.S. submarine cable pipe-line. Mr. Hartley is the chief engineer of the Anglo-Iranian Oil Company. Mr. B. J. Ellis, the late chief oilfields engineer of the Burmah Oil Company, is awarded £5000 for his invention of the H.A.M.E.L. pipe-line, which consisted of steel pipe welded together in sections and wound on a large drum. Mr. M. K. Purvis, who is now the Admiralty overseer at Cammell Laird's Birkenhead shipyard, is awarded £850 for his work in connection with the design and construction of the "Conun" drum on which up to 70 miles of the steel pipe-line was wound. Mr. A. E. Price, an Iraq Petroleum Company official, is awarded £250 for his invention of the wedge-gripping device, by which the pipe-line could be fixed near the shore and marked in position. The Royal Commission recommends no award to Resistance Welders, Ltd. Two further claims connected with the idea of the "Pluto" pipe-line have been put forward by Lord Napier of Magdala, and Captain T. A. Hussey, who was formerly Director of Experiments at the headquarters of Combined Operations, but the Commission has still to deal with these two claims.

The Future of Gatwick Airport

It is announced by the Ministry of Civil Aviation that the airport at Gatwick, Surrey, which originally was to be derequisitioned next month, is to remain under the control of the Ministry until the end of the year. Among the reasons for this decision is the fact that the Ministry of Civil Aviation is examining the question whether it will be possible for the State to assist privately-owned airfields by giving aid with technical services. A decision will be reached, it is expected, before the end of the year, and the Ministry regards it as advantageous for the meantime that Gatwick should remain under its control. It is also possible that Gatwick may still be needed as a diversionary airfield on the south of London. It is known that British European Airways is interested in the possibility of using Gatwick as a primary diversional airport, should at any time the weather conditions at Northolt, its terminal at present, or at London Airport, to which it will move in 1952, prove unsuitable. So far, the Stansted Airport, near Bishop's Stortford, has been put forward as an alternative. As, however, most of the Continental routes of British European Airways are to the south, it would naturally be more convenient to have a main diversionary airfield on the south side of London, and so do away with the need for flying over London to Bishop's Stortford.

Engineering and Machine Exhibition

No. I

THE Engineering and Marine Exhibition was opened at Olympia, London, yesterday, and will remain open until Saturday, September 10th. In the following article and the two Supplements which accompany this issue we describe a number of the exhibits. Our descriptions of the machinery and equipment on view will be continued next week in another Supplement and in the body of the journal.

BRITISH THOMSON-HOUSTON COMPANY, LTD.

Three items of d.c. diesel-electric marine propulsion equipment exhibited by the British Thomson-Houston Company, Ltd., form part of the machinery shortly to be installed in place of reciprocating steam engines in the "Balgowlah." The conversion of this double-ended ferry, which operates in Sydney Harbour and is owned by the Port Jackson and Manly Steamship Company, follows the same lines as the conversion of the "Barrenjoey" from steam to diesel-electric operation.

Each of these vessels is of 500 tons gross and has an overall length of 210ft and a passenger-carrying capacity of about 2000 persons. There is a propeller and control bridge at each end of both ferries and the design speed is 16 knots. The propulsion equipment, which operates on the constant-current series system, includes four 320-kW diesel-driven d.c. generators and four 615 h.p. motors—two driving each propeller—through a 790/158 r.p.m. reduction gearbox. A current of 1000A circulating through the main power circuit comprising the generator and motor armatures, is maintained within close limits by an "Amplidyne," which supplies and controls generator excitation. Speed control and reversal is obtained at the motor fields, while the possibility of overloading the diesel engines under any running condition is eliminated by the use of a motor field supply bucking "Amplidyne."

The three "Balgowlah" exhibits are an 8½-ton propulsion gearbox (Fig. 1), which during the Exhibition will be driven by a geared motor unit and fitted with "Perspex" covers so that the meshing of the gears can be seen; two generator panels; and an auxiliary engine-driven generator set (A.E.C./B.T-H.) with its "Amplidyne." The photograph reproduced in Fig. 1 shows the gearbox partly erected in the makers' works.

In this propulsion gearbox the two-pinion drive takes power from two B.T-H. 615 h.p., 790 r.p.m. motors and drives the propeller shaft at 158 r.p.m. The Michell bearing is embodied in the aft main journal bearing, with collar forged solid with the shaft. The gears are double helical and provided with a self-driven lubricating oil pump, which maintains the lubricating oil system in operation, whether the propeller be rotating in the ahead or astern direction. Oil from the pump is discharged through an oil cooler, thence to the oil sprays and bearings. The gears were specially designed to fit into an existing vessel, without alteration to height of propeller shaft. This requirement set a limit to the diameter of the low-speed wheel, which had to allow the gear case to clear the keelson. In consequence, the motor shaft centres are too close together to allow of the motor magnet frames being situated side by side; one frame with a long shaft had to be mounted ahead of the other.

The electrical control system is arranged so that the vessel is propelled entirely by the aft motors, the forward motors being rotated at a lower speed, with zero thrust at the Michell thrust bearing.

In the two-panel, dead-front generator switchboard as exhibited, all live parts are effectively shielded against personal contact. These panels control the four main generators, each rated 320kW, 320V, 1000A, 600 r.p.m. At full power all the generators are in a series circuit giving a total of 1280V, 1000A. The switches enable any generator to be taken out of, or switched into, the power circuit; sequence interlocks are provided to enable this operation to be carried out with the vessel in service.

The third exhibit in this group comprises an A.E.C. diesel engine, rated 63 b.h.p. at 1000 r.p.m., driving a B.T-H. direct-current generator, rated 40kW, 115V, 1000 r.p.m., and a B.T-H. four-pole "Amplidyne" exciter, rated 9·2kW, 115V, 1000 r.p.m. The 40-kW auxiliary generator is one of two per vessel and supplies the lights, power for the steering gear, and engine-room pumps. The excitation current for the propulsion motors is normally obtained from a 10-kW generator, vee-belt driven from one of the 500 h.p. main engines, but this supply can be taken from one of the 40-kW auxiliary generators if the main engine is out of service due to overhauling.

The 9·2-kW "Amplidyne" exciter also acts as a standby to a similar unit, vee-belt driven off another 500 h.p. main engine. A special requirement for these propulsion equipments is that a standby source of excitation power must always be instantly available and be capable of being brought into operation merely by the movement of a handwheel whenever the vessel is in passenger service.

Another B.T-H. exhibit of considerable general interest is a working demonstration of "Emotrol" (electronic motor control). This equipment, which uses thyratrons for controlling the speed of a d.c. motor, provides automatic speed regulation to within ±2 per cent over a wide speed range. In addition, "Emotrol" can be used for current-limit control, acceleration at constant current and dynamic braking. Operating on a.c. supply mains the control system requires no rotating

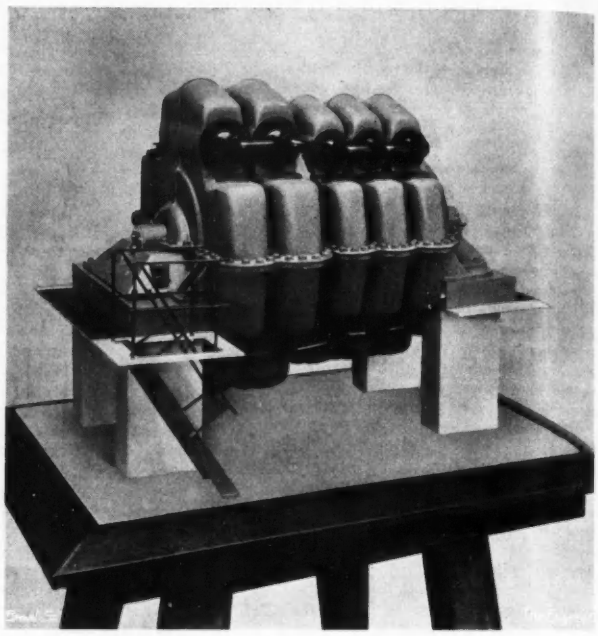


FIG. 2—MODEL OF MULTI-STAGE AIR COMPRESSOR—B.T-H.

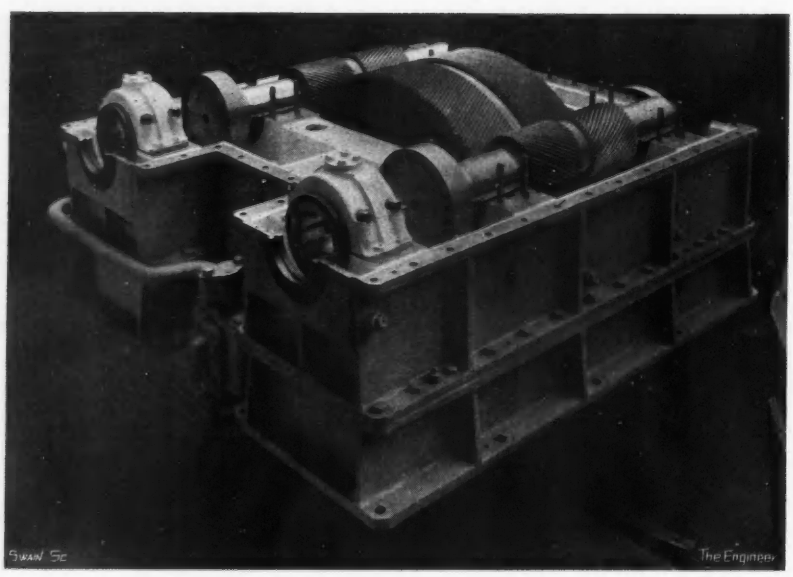


FIG. 1—PROPULSION GEARBOX OF FERRY "BALGOWLAH"—B.T-H.

machinery apart from the motor. The complete equipment comprises a control panel remote "stop" and "start" push buttons, a speed-control rheostat, the d.c. motor and, when necessary, a rectifier transformer.

"Emotrol" panels are available on a stock basis to give a speed range of 20 to 1 for 1 h.p., 3 h.p., 7½ h.p. and 15 h.p. motors, and equipments can be supplied specially to control motors up to 750 h.p. When fine speed control is required, "Emotrol" control panels can be supplied to maintain motor speeds within limits of ±2 per cent.

An exhibit on the B.T-H. stand of unusual interest is the model (see Fig. 2) constructed on a scale of 1in to 1ft of the new multi-stage air compressor embodying Oerliken patents, which has been designed for a duty of 20,000 cubic feet of air per minute at 100 lb per square inch pressure. It can now be announced that the British Thomson-Houston Company, Ltd., has acquired the right to manufacture air compressors for gas turbine and other duties, incorporating the patented diffuser system developed by the Ateliers de Construction Oerlikon, of Zurich-Oerlikon, Switzerland, which was developed in connection with the Oerlikon gas turbine.

That principle was fully described and illustrated in our articles reviewing gas turbine progress, which were published in our issues of January 17 and 24, 1947. Each diffuser, we may recall, consists of a single-spiral volute, and a straight conical diffusing passage, four diffusers generally being placed 90 deg. apart, an arrangement which provides a high adiabatic efficiency.

The example shown has five stages of intercooling, each consisting of four tubular coolers. This new development makes an interesting addition to B.T-H. compressing plant of the centrifugal pattern, including compressors, blowers, gas-exhausters and gas-boosters, which have been made at Rugby for many years and have covered a wide range of applications.

Alfa-Laval Company, Ltd.

The display of its products arranged by Alfa-Laval Company, Ltd., Great West Road, Brentford, Middlesex, includes representative types of lubricating and fuel oil purifiers, centrifugal separators, clarifiers, &c. The specialised equipment shown includes that for the treatment of boiler fuel oil to make it suitable for use as diesel fuel. The company's "VIB.1929 C" purifier/clarifier, used for this purpose, is illustrated in Fig. 3. This machine removes the water, earthy matter and particles of inorganic ash suspended in boiler fuel oil. In a typical installation the equipment is laid down to work in series, a machine in the first stage removing water and sludge and a second machine extracting the remaining finely divided solids and some of the slow-burning constituents in the oil.

The cast hood of the machine is hinged to the rear of the frame and can be thrown back to expose the bowl to view. The inlet pipe for unpurified oil is swivel jointed to the hood, and the oil and water receiving chambers in the hood meet corresponding collecting chambers in the frame. All the piping is permanent and there are no flexible connections to break when raising the hood, which, when closed, makes a gastight joint with the frame.

The bowl contains a set of strong self-cleaning conical discs, between which separation rapidly takes place, and an ample sediment space is provided for collecting heavy dirt separated out. A bowl can be arranged to work either as a purifier or a clarifier. As a purifier two discharge outlets are provided, one for purified oil and the other for separated water and solids; as a clarifier one outlet only for the oil is provided. When a bowl is arranged as a purifier, separated water is continually discharged, and the bowl can be easily adjusted for treating oils of specific gravities from 0·84 to 0·985. Such a bowl automatically adjusts itself to variations in the proportions of oil and water, and by increasing the water flow solid matter can be flushed out of the water outlet. The bowl is self-draining; when it stops revolving the oil and water in it flows out through drainage holes in the base into a special drain arranged in the frame.

Oil transfer pumps can be fitted to deliver oil to and/or from the purifier. These pumps are of the rotary gear type with a suction lift of about 13ft and deliver against a pressure head of 45ft.

B. and P. Swift, Ltd.

A new single-stage gear pump of simple, compact design, designed to work at pressures up to 2500 lb per square inch and for intermittent running up to 3000 lb per square inch, is shown on the stand of B. and P. Swift, Ltd., Century Works, Lewisham, London, S.E.13. For this pump a gear tooth form has been developed to prevent the building-up of high pressures by oil being trapped between the teeth as they engage, and a system of oilways serves to centre the gears between the side plates.

The general arrangement of the new pump can be seen in the drawing, Fig. 4, and the gear-tooth form adopted in the illustration

Fig. 5—Gear Pump—Swift

Fig. 5. The construction of the pump is comparatively simple: it consists of a centre-plate machined to receive the gear-wheels and two plain side plates built up on to a flanged member for attachment to a driving motor or other mounting. To prevent the building-up of pressure by oil being trapped between the gear teeth, the teeth are relieved on the flanks as shown in Fig. 5. In the case of larger gears reliefs are milled on the tooth flanks.

Clearances in this type of pump are not made unduly fine and leakage from the delivery side to the suction side across the flat faces of the gear wheels is permitted by a small side clearance, which is automatically maintained equal on both faces. The method adopted for maintaining this clearance is shown in the diagramatic arrangement in Fig. 6. High-pressure oil is

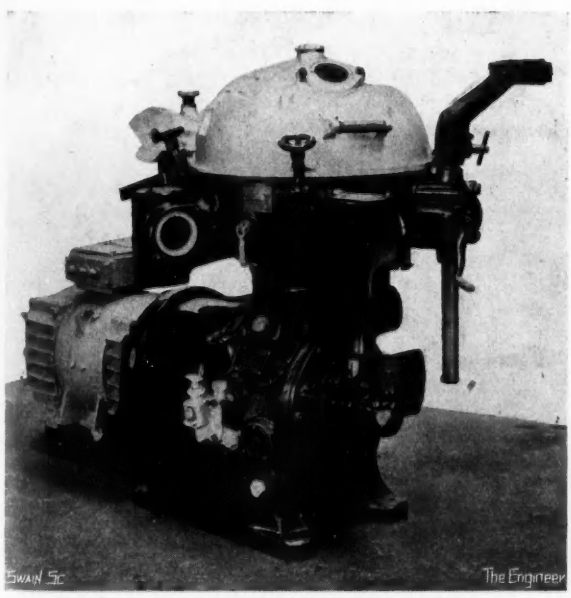


Fig. 3—Oil Purifier—Alfa-Laval

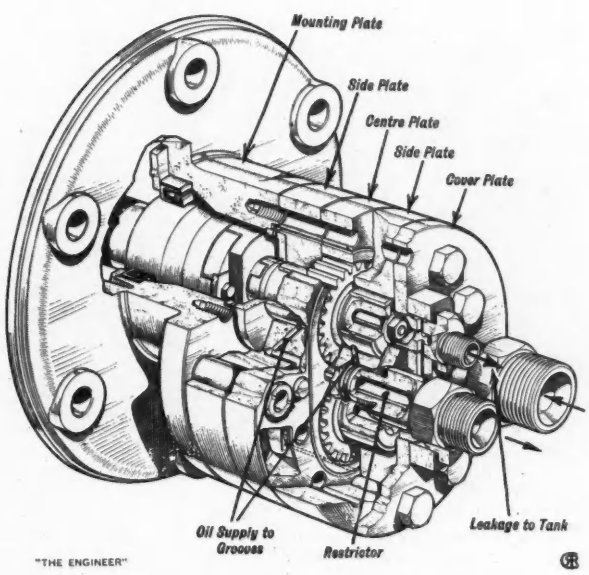


Fig. 4—Arrangement of Gear Pump—Swift

supplied to an annular groove *A* in each of the bearings and bushes. The fluid under high pressure leaks from this annulus past the side faces of the gears to exert an equal force on each side of the gear and serves to centralise it within the side plates. Leakage of oil from the periphery of the delivery side radially towards the gear wheel journals also tends to centralise the gears automatically. The supply of high-pressure oil to the annuli of the bushes is maintained under low load conditions through a restrictor situated in the pump outlet.

A groove machined in each side of the pump centre plate around the openings for the gear-wheels is designed to collect any

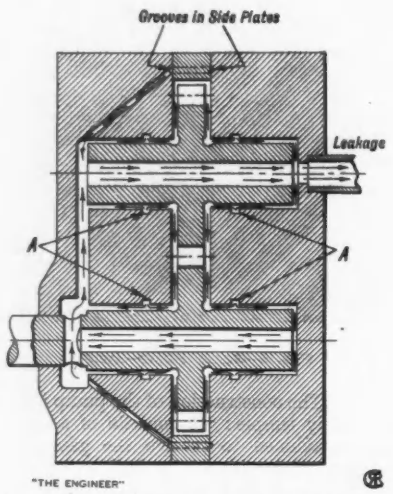


FIG. 6—DIAGRAMMATIC SECTION THROUGH GEAR PUMP—SWIFT

oil leaking between the plates. This oil at low pressure forms a seal, which prevents air entering the pump and causing frothing of the oil. The oil leaking into these grooves and that from the bearings is returned to the oil supply tank through a special pipe connection.

The makers have standardised a number of basic frame sizes and gears and this combined with the interchangeability of parts has made it possible to build pumps from standard components to deliver from ½ gallon per minute to 200 gallons per minute. A selection of valves and other accessories for these pumps enables complete hydraulic installations of many sizes readily to be constructed. These accessories include relief, flow control, pressure unloading and pressure reducing valves, selector valves, &c.

HALL HARDING, LTD.

The many interesting and useful drawing-office accessories selected by Hall Harding, Ltd., Stourton House, Dacre Street, London, S.W.1, for purposes of exhibition include a new adjustable drafting square known under the trade name "Clintax." This instrument is intended for use in conjunction with a tee-square or straightedge, and combines in a single unit a set-square, protractor and scale.

The "Clintax"—see Fig. 7—is made in white "Perspex," and on the body the circle and vernier are accurately divided and figured in red and black. The limbs are coloured to correspond with the scale to show at a glance the relative angle of each limb with the horizontal. At each end of the protractor scale eccentric stops are fitted to limit the range of movement to 90 deg. Twelve-inch scales are attached to each limb by means of coin-slotted screws and adjustment is provided to permit the setting of the scales precisely at right angles. Each scale has fixing holes at both ends, so that they can be reversed and the required scale edge presented in the drawing position.

The instrument can be used with any tee-square or straightedge in the usual way, but by the use of a simple fitting it can be attached to and become part of a long straightedge and, at the same time, be moved laterally with complete freedom. A drawing surface can be completely covered by fitting an attachment to both the upper and lower ruling edges of the straightedge.

A simple instrument known as the "Pararule" is made by the firm for attachment to small drawing boards to replace the ordinary tee-square. It consists of a special form of straightedge which is attached to the board by nylon guide cords down each side. These cords are held in position by means of small tensioning brackets and pass over guide wheels in the straightedge assembly. The arrangement is such that once the instrument is set the straightedge can be moved freely up and down the board on the guide cords which retain it in true alignment throughout its range of movement.

The recently introduced "Chisilient" pencils to be seen upon this stand will be of interest to draughtsmen. In these pencils lead refills are secured by a rubber sleeve in such a way that they are not broken however tightly the cap is screwed home. This rubber sleeve is compressed on the lead when the cap is tightened and a small metal washer bonded to the base of the sleeve prevents it binding on the end of the hexagonal holder. The sleeve and the lead rotate with the cap and when a new length of lead is being fed through, the remains of the previous chisel point on the lead can be aligned with the flats on the cap and this alignment retained during tightening up. When a pencil is accidentally dropped, the rubber provides a cushioning effect against shock to reduce the likelihood of lead breakage.

RANSOMES, SIMS AND JEFFERIES, LTD.

Two forklift battery-operated trucks are to be seen among the different types of electric vehicles exhibited by Ransomes, Sims and Jefferies, Ltd., of Ipswich.

The smaller of these two trucks, the "Forklift 20," has a lifting capacity of 1 ton at 18in centres from the heel of the forks and a maximum lift of 10ft. The lifting speed with a full load on the forks is 22ft per minute, and with no load 40ft per minute. With a full load the truck can be driven up to 5·6 m.p.h. and when unladen at 6 m.p.h.

The general arrangement of the vehicle can be seen in Fig. 8. The rigid fabricated chassis of the truck is built up of standard rolled steel sections. A ballast weight bolted to the rear of the main frame gives extra rigidity and also provides protection for the battery. The driving motor is connected to the front wheels through a differential and totally enclosed worm reduction gear, the final drive to the wheels being transmitted through splined shafts. To simplify maintenance and inspection the driving motor, transmission and wheels are assembled as a single removable unit.

The lifting and tilting motions of the fork lift are hydraulically operated through two separate control handles, the valve arrangement being such that the two movements can be effected simultaneously. Pressure fluid for the hydraulic system is supplied by a rotary pump driven by a separate motor. The control valves for lifting and tilting are interlocked with the starter of the pump motor so that no current is used until power is required. The lifting carriage runs on rollers inside the upright channel guides, and is, by the usual compounding movement, raised by heavy chains guided over sprockets on the ram head.

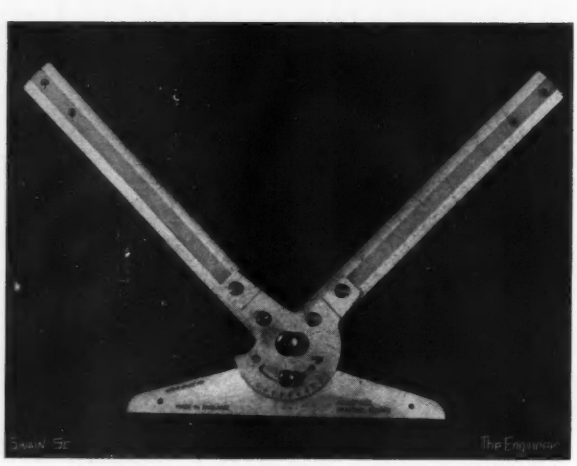


FIG. 7—ADJUSTABLE DRAFTING SQUARE—HALL HARDING

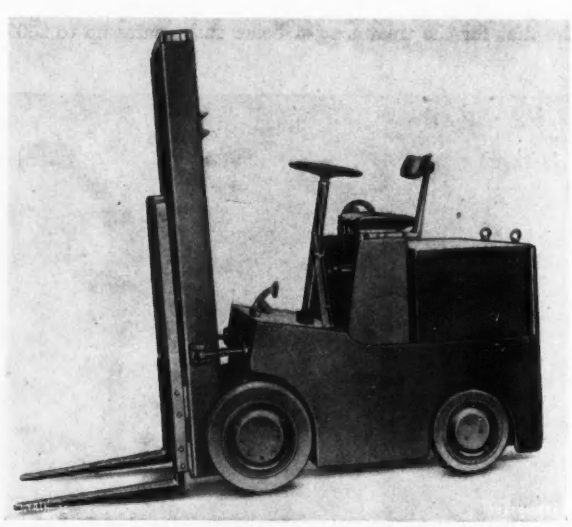


FIG. 8—ELECTRIC-HYDRAULIC FORKLIFT TRUCK—RANSOMES, SIMS

(*To be continued*)

American Railroads

No. III—(*Continued from page 189, August 19th.*)

(*Contributed*)

No. III—THE RUNNING OF SOME AMERICAN RAILWAY TRAINS

TO the visitor who, interested in the equipment and operation of passenger trains, can compare his notes on traffic working in the United States made forty-eight years ago with the working of corresponding trains to-day, there must come some major surprises.

The changes are startling and the most spectacular relate to the up-to-date motive power, now predominantly of diesel-electric type. In 1901 Mr. William Buchanan—who designed the famous "999" long conspicuous on the New York Central—was still alive though the express locomotives working the crack trains on the N.Y.C. in 1901 were of what became known as the "Central Atlantic" type. It happens that the writer has preserved the log of a journey which he made in the "Empire State Express" on December 24, 1901, and as an introduction to what follows in this article, it is reproduced below :—

	Actual	Booked	
Leave New York (Grand Central)...	8.47 a.m.	8.30 a.m.	(Engine No. 2998, "Central Atlantic" type)
(Stop outside 125th Street, and three bad checks between Spuyten Duyvil and Albany)			
Arr. Albany (143 miles)	11.15 a.m.	11.10 a.m.	(148 min., average speed, 59·96 m.p.h.)
Leave Albany	11.18.30 a.m.	11.13 a.m.	(Engine No. not observed)
Arr. Utica ...	12.58 p.m.	12.55 p.m.	
Leave Utica ...	1.1.30 p.m.	—	
Arr. Syracuse	2.0 p.m.	1.58 p.m.	
Leave Syracuse	2.5 p.m.	—	(Engine No. 2999, "Central Atlantic" type)
Arr. Rochester (370 miles)	3.24 p.m.	3.25 p.m.	(397 min., inclusive)

Notes Re Times and Train

The distance from Syracuse to Rochester is just 80 miles, run on this occasion in exactly 79 min., giving an average speed of 61 m.p.h. Seventeen consecutive miles between Syracuse and Rochester were covered in exactly 14 min., or at an average speed of 73 m.p.h.

It will be seen that the train improved upon the booked allowance to the extent of 18 min., 415 min. being allowed and 397 min. taken.

Engines of Schenectady-built "Central Atlantic" type ten-wheeled, four-coupled driving wheels, 6ft 6in, two cylinders 21in by 26in, weight without tender 78½ tons.

Train weight about 178 tons, each of the four twelve-wheeled vestibuled cars weighing about 44½ tons loaded. Weather cold, light side wind, snow at times.

To-day this same train, hauled by diesel-electric locomotives, is allowed 409 min. for the 370 miles separating New York and Rochester. Accordingly, the booked time to-day is only 6 min. faster than the booked time forty-eight years ago, that is, while in 1901 the average speed, including stops,

	Eastern standard time
Leave New York (Grand Central)	8.0 a.m.
Leave 125th Street	8.10 a.m.
Leave Harmon	8.48 a.m.
Arr. Albany	10.42 a.m.
Leave Albany	10.42 a.m.
Leave Schenectady	11.13 a.m.
Arr. Utica	12.30 p.m.
Leave Utica	12.32 p.m.
Arr. Syracuse	1.22 p.m.
Leave Syracuse	1.28 p.m.
Arr. Rochester	2.49 p.m.

was 53·5 m.p.h., the average speed to-day is 54·3 m.p.h. an increase of only 0·8 m.p.h.

The present-day (April, 1949) timing of the "Empire State Express" is given above.

It will be noted that there are now additional stops at 125th Street and Harmon and the additional stop at Schenectady to set down passengers from Harmon and New York and to take up west-bound passengers. There is, moreover, a vast difference in the tare weight of the train, which, with sixteen coaches, will be between 800 tons and 900 tons, or approximately five times the weight hauled in 1901.

This point of the persistence of the train speed is emphasised in order to remove the popular impression that the diesel-electric locomotive has had a revolutionary effect on train speeds in the United States. In the case of one of the oldest and best-known trains in the United States the speed has remained unchanged for half a century.

There can be no question whatever as to the capacity of the steam locomotives—notably the mighty "Mohawks"—to do anything with the "Empire State Express" which can be done by the diesel-electric locomotives. The "Advance Empire State Express" (train No. 55) is regularly hauled by a "Mohawk," and the log of a run made with this train—East-bound—in May, 1949, is given below :—

	p.m.	Distance, miles	Time (actual), min. sec.
Dep. Buffalo ...	12.30.30	... —	—
Arr. Batavia ...	1.07.10	... 33·5	36 40
Dep. Batavia ...	1.12.00	... —	—
Arr. Rochester ...	1.45.00	... 32·5	33 00
Dep. Rochester ...	1.48.10	... —	—
Arr. Syracuse ...	3.02.00	... 80·3	73 50
Dep. Syracuse ...	3.12.00	... —	—
Arr. Rome ...	3.45.00	... 39·0	33 00
Dep. Rome ...	3.46.40	... —	—
Arr. Utica	4.04.20	... 13·8	17 40
Dep. Utica	4.15.30	... —	—
Arr. Amsterdam	5.13.15	... 61·8	57 45
Dep. Amsterdam	5.20.10	... —	—
Arr. Schenectady	5.37.00	... 15·9	16 50

The engine on this occasion was No. 6005 ("Mohawk"), with fourteen-wheeled tender (18,000 gallons of water, 46 tons of coal). The train consisted of nine coaches (four-wheeled bogies) from Buffalo; three milk cars (four-wheeled bogies), and one parlour car added at Syracuse; one parlour car and one day coach added at Utica. There was an unbooked stop (15 sec.) at Little Falls Station (between Utica and Amsterdam) and the approach to all stopping points was extremely slow. The maximum observed speed was 80 m.p.h., reached between Syracuse and Rome. The inclusive booked time, Buffalo to Schenectady, is 305 min. The actual time, inclusive of stops, was 306 min. 30 sec. The actual running time was 268 min. 45 sec. and

	a.m.	Distance, miles	Time (actual), min. sec.
Leave Schenectady	8.35.00	... —	—
Arr. Albany ...	8.56.00	... 16·9	21 00
Leave Albany ...	9.10.00	... —	—
Arr. Poughkeepsie	10.11.30	... 69·4	61 30
Leave Poughkeepsie	10.15.00	... —	—
Arr. Harmon ... (Diesel-electric locomotives detached at Harmon)	10.56.00	... 40·1	41 00
Leave Harmon ...	11.01.30	... —	—
Arr. New York (42nd Street) ...	11.48.00	... 32·7	46 30

the distance is 276·8 miles. The engine crew was changed at Syracuse.

On a succeeding journey, made a few days later with the "Knickerbocker" (train No. 24), east-bound from Schenectady to New York with a load of between 900 tons and 950 tons, two General Motors diesel-electric locomotives (0–6–6–0) took 141 min. from leaving Schenectady to arriving at Harmon. The booked time is 148 min., including the stops at Albany, Poughkeepsie and Harmon, so that with this tremendous train the locomotives improved on the booked allowance by 7 min. The actual times and distances are given above.

It should be explained that apart from long slacks approaching and passing Hudson and approaching Poughkeepsie, the speed between Stuyvesant and Poughkeepsie—a distance of 51 miles—did not fall below 80 m.p.h. and did not exceed a maximum of 82 m.p.h. There were, moreover, repeated slacks due to track repairs between Poughkeepsie and Peekskill and between Peekskill and Harmon. The total distance from Schenectady to New York (Grand Central) is 159·1 miles. The booked inclusive time is 206 min., the time (inclusive) actually taken was 193 min. The net actual time with station stops deducted was 170 min. The times given in the above log are taken from the observer's watch and are thus one hour later than the Eastern Standard Time shown in the official time table.

Journeys in the "Advance Empire State Express," the "De Witt Clinton," and other trains worked by steam locomotives, will certainly confirm the capacity of the "Hudsons" (4–6–4) and the still more powerful "Mohawks" (4–8–4) to haul any passenger trains at the highest permitted speeds or at any speeds which could be reached without adverse effects on the crews. These engines—and notably the "Mohawks"—can haul 1000-ton express passenger trains with an ease which has to be seen to be realised. At present the permitted speed limit is 80 m.p.h. with a tolerance of 5 m.p.h. In the course of the writer's observations of the working of heavy passenger trains between Harmon and Buffalo, he rarely encountered a train which was not running before time. Arrivals at Buffalo were invariably from 4 min. to 10 min. before time whether the trains were hauled by two 0–6–6–0 diesel-electric locomotives or by one "Mohawk" steam locomotive. In connection with the notable punctuality of arrivals of west-bound express trains at Buffalo, it should be mentioned that these trains have the advantage of the magnificent run-in from Corfu, where, for a stretch of about 22 miles, the four-track-line is almost dead straight and lies on a slightly falling gradient towards Buffalo. The solidity of the permanent way contributes to rendering this section of the line peculiarly suitable for fast running, and it was here, indeed, that the N.Y. Central carried out, some time ago, exhaustive high-speed tests with heavy trains.

It had long been the desire of the writer to see for himself the working of the "Hiawathas" out of Chicago, and he was able, during April, 1949, to travel on the west-bound "Morning Hiawatha." The distance from Chicago (Union Station) to Milwaukee is just 85 miles and the time allowed to the "Morning Hiawatha" (depart Chicago 10.30 a.m., arrive Milwaukee 11.45) is 75 min., which calls for an average speed, start to stop, of almost exactly 68 m.p.h. It is true that the track of the Chicago, Milwaukee, St. Paul and Pacific Railroad between Chicago and Milwaukee (apart from certain short radius curves immediately outside Chicago and Milwaukee) is remarkably free from bends and virtually level,

the difference in altitude between Chicago (583ft) and Milwaukee (595ft) being only 12ft. Moreover, the roadbed, laid out for high speed, is regarded as among the best in the United States.

When the present writer travelled by this train it was made up to thirteen of the latest air-conditioned coaches all on four-wheeled bogies, and hauled by two diesel-electric locomotives of the 0–6–6–0 wheel arrangement built in 1946 by the Electro-Motive Division of General Motors. Leaving Chicago at 10.36.00 (the reason for the late departure was not apparent) the train proceeded very slowly through the station yard and adjacent suburbs, coming almost to a dead stop at Western Avenue. Thereafter, acceleration was rapid and Sturtevant (62 miles from Chicago) was passed at 11.26.15, the distance being covered in 50 min. 15 sec. Approaching Milwaukee, the speed was reduced nearly to walking pace across the swing bridge and over the two level crossings immediately outside the station, Milwaukee being reached at 11.47.10 (dead stop). The actual time from dead start in Chicago to dead stop in Milwaukee was thus 71 min. 10 sec., which is 3 min. 50 sec. inside the booked time and corresponds with an average speed of 71·6 m.p.h. The time could certainly have been improved upon to the extent of at least 4 min. but for the long, protracted slack from Union Station to Western Avenue and the extremely slow approach to Milwaukee. The travelling was conspicuously smooth and a passenger could not without close observation of the transit time have supposed that the greater part of the journey was accomplished at a speed in excess of 80 m.p.h.

The return journey from Milwaukee to Chicago with a train made up to fourteen air-conditioned coaches (all on four-wheeled bogies) hauled by two 0–6–6–0 diesel-electric locomotives (Electro-Motive) was accomplished in exactly 72 min., departure from Milwaukee 6.00.00 p.m., arrival at Chicago 7.12.00 p.m., which is 3 min. inside the booked time. On this journey the last 4 miles of the approach to Union Station, Chicago, was extremely slow, the train being much before time.

It is to be noted that the track of the Milwaukee Road from Chicago to Milwaukee crosses practically all the numerous public highways at the level, including roads in built-up areas, such as Sturtevant. It must surely cause a certain liveliness in these places when the "Hiawathas" flash through at speeds of between 80 and 90 m.p.h. The crossings are rarely closed by any barriers but are marked by such devices as semaphores, red-lamps and "wig-wags."

Among other lines radiating from Chicago —surely the most impressive railway centre in the world—is the Gulf, Mobile and Ohio Railroad, the whole of whose main line passenger and freight trains between Chicago and St. Louis are now hauled by diesel-electric locomotives. All switching is likewise done by diesel-electric locomotives and while a certain number of steam locomotives are still employed on unimportant trains, no more are to be ordered. In May of this year the writer made a journey from Chicago to Springfield (Ill.) on the air-conditioned train "Ann Rutledge," one of the crack streamlined trains of the Gulf, Mobile and Ohio Railroad. It consisted on this occasion of thirteen four-wheeled bogie coaches drawn by two 0–4–4–0 diesel-electric (General Motors) locomotives.

	a.m.	Distance, miles	Time (actual), min. sec.
Dep. Chicago (Union)	8.27.00	—	—
Arr. Joliet	9.12.00	37	45 00
Dep. Joliet	9.15.00	—	—
Arr. Dwight	9.47.00	37	32 00
Dep. Dwight	9.49.00	—	—
Arr. Pontiac	10.08.00	18	19 00
Dep. Pontiac	10.08.30	—	—
(Slow to nearly dead stop outside Bloomington)			
Arr. Bloomington	10.41.30	35	33 00
Dep. Bloomington	10.47.00	—	—
Arr. Lincoln	11.14.00	29	27 00
Dep. Lincoln	11.15.00	—	—
Arr. Springfield	11.44.30	29	29 30
Total		185	185 30

The log of the run with distances and actual times is given above, the times being exclusive of the time occupied by station stops.

The time table allows 195 min. for the 185 miles, giving an inclusive average speed of 56·9 m.p.h. On the occasion of the above journey the time taken was 197 min. 30 sec., the inclusive average speed being 56·25 m.p.h. Deducting the time occupied by dead stops in stations, the time was 185 min. 30 sec. Just outside Springfield the "Ann Rutledge" was passed by the north-bound "Abraham Lincoln" (8.58 a.m. diesel-electric air-conditioned train from St. Louis) running about 40 min. late.

The passenger in the "Ann Rutledge" has the opportunity of surveying, close beside the line, the automobile traffic on the adjacent high road, which runs close to the railway over the greater part of the distance from Chicago to Springfield. He beholds an amazing procession of large automobiles, which, gleaming with brilliant colours and chromium-plating, indulge in surprising bursts of speed and sometimes in protracted efforts to overtake or keep pace with the streamlined train. It is an astonishing and lively spectacle, illustrating the competition which the railway is up against; so also does the truck traffic on the highway and the ample provision, along the road, for the sustenance of truck drivers. The fields are full of mechanised farming equipment and the whole State of Illinois seems to be humming with internal combustion engines from the diesel engines on the locomotives and the tractors to the gasoline engines on the trucks, buses and automobiles. We saw not a single horse in a stretch of 185 miles. That formerly universal power unit seems to be disappearing from the United States.

Returning from Springfield in the "Alton Ltd." (Gulf, Mobile and Ohio R.R.) made up to nine twelve-wheeled coaches and hauled by two 0–4–4–0 diesel-electric locomotives (General Motors) the times and distances were as under :—

	Booked, p.m.	Actual, p.m.	Distance, miles	Time, min. sec.
Dep. Springfield	1.54.00	2.02.00	—	—
(Prolonged slack between Sherman and Williamsville)				
Arr. Bloomington	2.50.00	2.56.00	58	54 00
Dep. Bloomington	2.55.00	3.07.00	—	—
Arr. Pontiac	—	3.37.00	35	30 00
Dep. Pontiac	3.30.00	3.38.00	—	—
(Very slow through Dwight, prolonged slack between Branceville and Braidwood, very slow approach to Joliet)				
Arr. Joliet	—	4.28.00	55	50 00
Dep. Joliet	4.27.00	4.30.30	—	—
Arr. Chicago (Union)	5.15.00	5.15.00	37	44 30

The total distance, Springfield-Chicago, is 185 miles, and the booked time (inclusive of stops) 201 min., giving an average inclusive booked speed of 55·21 m.p.h. The actual time (inclusive of stops) was 193 min., giving an average speed (inclusive of stops) of 57·5 m.p.h.

The sheer comfort of the air-conditioned trains which have been mentioned would need to be experienced in order to be believed. The travelling was extremely smooth, applications of the brakes joltless and the dining car facilities admirable. Arriving at Union Station, Chicago, and while approaching through the extensive yards, the writer saw only a single steam locomotive, a solitary "Pacific" of the Chicago, Burlington and Quincy R.R. Beside the diesel-electric locomotives of the "California Zephyr" it looked like a museum piece.

It would not be too much to say that if the comfort, speed and appearance of the modern American passenger railway train amazes the visitor from Europe, he is apt to be still more amazed by the contrast between the large American railway stations and the corresponding stations in Europe. This also must be seen to be believed and so far as concerns British railway stations, the first need is for a higher—even if not yet an American—order of cleanliness. Magnificence can come later, but we may surely expect to find in our terminal stations at least something of the attractiveness which characterises the corresponding stations across the Atlantic. This attractiveness is good for business and is part of the real effort made by the American railroads to serve the travelling public. There are, of course, basic differences in respect of the type of traffic. This is well seen in such a terminal as the Union Station, Chicago, Ill., where one can find in the beautifully kept shops almost anything which may be required by a long-distance passenger, even the services of a dentist being available.

While the present notes refer specifically to conditions in the United States, it should be mentioned that a corresponding order of comfort obtains also on the crack Canadian trains. It is true, of course, that in Canada, the important trains out of Toronto towards the United States are hampered, in respect of overall journey time, by delays and stoppages at frontier points. Travelling, for example, in the "Canadian" of the C.P.R., though passport and customs formalities are dealt with en route, delays due to electric traction through the Windsor-Detroit tunnel involve a severe addition to the total running time between Montreal and Chicago. As it is, the going is pretty good and the equipment excellent. This particular train is steam-hauled throughout except for the electric haulage through the International tunnel connecting the Province of Ontario with the State of Michigan. On the Canadian side the locomotives are either 4–6–4 or 4–8–4 and some fast running is to be observed between Montreal and Toronto and after leaving Woodstock for Windsor. On the Michigan side (the train weight being greatly augmented at Detroit) an N.Y. Central steam locomotive—"Hudsons" and "Mohawks" being used—works through to Chicago (Central), the Detroit crew being changed at Niles. The distance from Toronto to Chicago is 512·3 miles, and there is no difficulty in keeping time with the very heavy trains where the average inclusive speed is a shade under 50 m.p.h.

On the international section, Toronto-Buffalo, trains for New York take 195 min. to cover the 102·1 miles, an average speed of 31·4 m.p.h. This is inclusive, however, of the standing time at Fort Erie and Black Rock, and of the necessarily dead slow progress over the Welland Canal, the International bridge and through the streets approaching Buffalo. The locomotives used between Toronto and Buffalo are Canadian-built 4–6–4s and "Pacifics," though the N.Y. Central has running powers as far as Hamilton, Ont.

Hydro-Electric Power Plants in Central France

By Dipl.-Ing. C. CARTY

No. II—(*Continued from page 195, August 19th*)

Couesque Plant

THE dam at Couesque is of the "thin arch" type, with a downstream overhang as shown on the cross-sectional elevation, Fig. 15. The total height of the dam is 215ft, the depth of the foundations being 16ft 4in. The volume of the dam is 100,000 cubic yards. The excavation for the abutments was driven, dependent on the strata, between 4ft 11in and 6ft 6¾in deep into the rock forming the banks of the Truyère. The radius of the crest of the dam is 289ft and its length amounts to 892ft 4in, of which 574ft are available as a spillway. The crest is provided with dividing projections in order to prevent the development of any vacuum effect between the arch of the dam and the overflowing sheet of water. The total capacity of the Couesque reservoir will be 56,000,000 cubic metres, of which 20,000,000 cubic metres will be available for power production. The maximum level of the reservoir is fixed by the level of the Brommat tail-race, which is at a distance of 8¾ miles upstream from the Couesque dam. Fig. 15 also shows a section through one of the three discharge pipes for draining the reservoir.

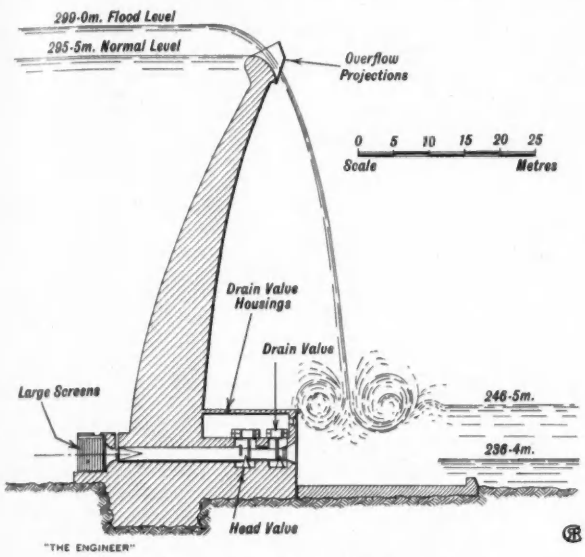


FIG. 15—SECTION THROUGH COUESQUE DAM

The aggregates used for the concrete of the dam are being obtained from gravel pits excavated along the bank of the Truyère River, some distance upstream from the dam (Fig. 16). These pits are being excavated by means of ½ cubic yard shovels, the material being collected in 5-tonne, three-bin lorries for transport to the primary rotary crusher (shown at the centre of Fig. 16 and on the extreme right of Fig. 17), which has an hourly rating of 120 tonnes of 180mm size (7in) material. After preliminary crushing the material is carried to the stockpile by means of a 2ft 7½in wide belt conveyor having a length of 360ft and an angle of rise of 18 deg. The washing, screening and secondary crushing plant is alongside the stockpile. The aggregate is stocked according to size in five silos of 1300 cubic yards capacity, the sizes being 0mm to 2mm, 2mm to 10mm, 10mm to 30mm, 30mm to 80mm, and 80mm to 180mm. Secondary crushing is carried out with a jaw crusher and with two vibration crushers.

An aerial ropeway of 60 to 80 tonnes' capacity per hour carries the crushed material to two concrete plants at the dam site, about 3 miles distant. One of the two plants is able to supply 46 cubic yards per hour of 180mm concrete, while the other supplies 30mm or 80mm concrete at a rate of 19·5 cubic yards per hour. Pipes connect the two concrete plants with two 500-tonne cement silos, built up from steel plates and stanchions to a diameter of 21ft 3⅞in and an overall height of 55ft 9in. The cement is delivered in bulk to the two silos by means of tipping lorries.

Fig. 18 shows the general lay-out of the plant and equipment provided on the site for the construction of the Couesque dam and power station. It will be noticed that the concrete plants and the cement silos are situated between the dam and the power station. Two cableway cranes of 6 tonnes each will be available for the construction of the dam itself, while for the erection of the power station there will be three cableway cranes of 3 tonnes each and two others of 5 and 2 tonnes.

At Couesque the power station is not immediately downstream of the dam, but it is on the right bank, below a rock projecting into the river bed at this point (Fig. 19). Two tunnels of horseshoe section with 16ft 4in maximum diameter and of 640ft and 542ft lengths respectively are being driven through this rock. Each tunnel is provided with a surge chamber. Two 13ft 9⅜in diameter conduits will supply the two future turbo-alternator sets. They will be Francis type turbines with vertical shafts having an output of 43,000 h.p., to be supplied by Neyret-Beylier, of Grenoble. They will run at a speed of 214 r.p.m. and drive Als-Thom alternators of 32,000kVA at 15kV, provided with closed circuit ventilation systems.[3] The 800-kVA auxiliary set will have a horizontal shaft. The transformer station will be situated immediately upstream of the power station, and there will be two 15/220-kV transformers, one for each alternator.

The Couesque power plant will also use the energy provided by a small tributary on the right bank of the Truyère called the Goul. The waters of this stream will be retained by a 52ft 6in. high gravity dam and fed into the main reservoir through a tunnel of 8·6 square yards cross section and 2·1 miles long.

The Maury Dam

The River Selves, a tributary on the lower left bank of the Truyère, has also been harnessed for power production. The lay-out, of standard design, consists of a reservoir formed by the Maury dam and the power station of Lardit on the Truyère, together with tunnel and penstocks as shown on the plan, Fig. 20, and on the longitudinal profile, Fig. 21, of the whole installation.

The Maury dam, Fig. 22, is also of the "thin arch" type. The sluices for flood overflow and for draining the reservoir are embedded in the body of the dam. The height of the dam above the bottom of the valley is 216ft 6in, while the thickness at the

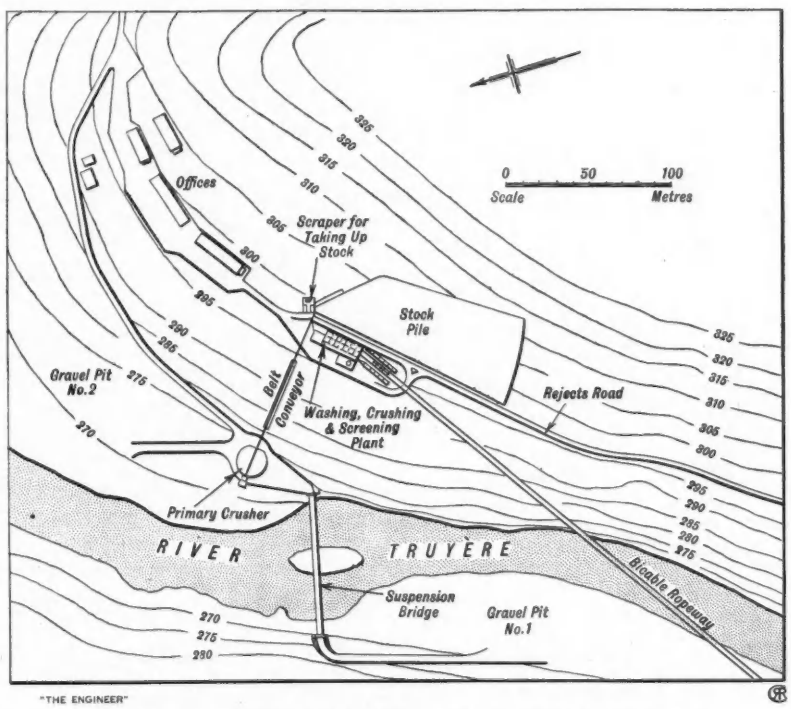


FIG. 16—GRAVEL PITS AND CRUSHING PLANT FOR COUESQUE DAM

[3] *Travaux*, January, 1948, page 50.

base is 59ft, tapering to 6ft 6¾in at the top, with a length at the crest of 590ft 6in, corresponding to 89,000 cubic yards of concrete and 5232 cubic yards for the foundations. The reservoir has a capacity of 35,300,000 cubic metres, of which 33,000,000 may be utilised. The maximum level is fixed at 588·50m (1930·8ft a.D.), to which corresponds a covered area of 410 acres and a head of 1155ft.

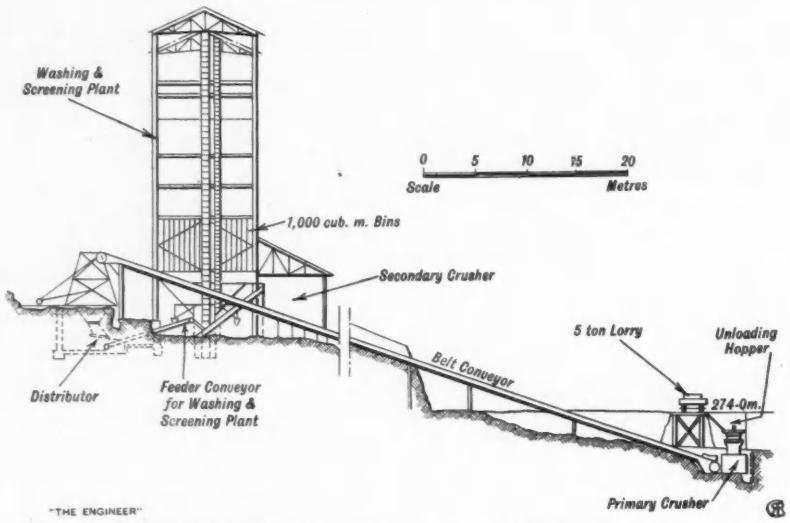


FIG. 17—CRUSHING AND SCREENING PLANT, COUESQUE DAM

A tunnel of 8·36 square yards cross section carries the water to a forebay above the power station. It is 3·62 miles long and is designed for a flow of 53 cusecs at a speed of 7ft per second. A surge chamber is provided near the end of the tunnel—Fig. 21. Two pressure pipes lead down to the power station.

These pipes are interesting, in that they are probably the first operating at such high pressures to be manufactured from prestressed concrete. Their test pressures varied between 256 lb and 853 lb per square inch. The service pressure of the lower units rises to 500 lb per square inch. The outside dimensions of the pipes, namely, diameter 5ft $11^{21}/_{32}$in and length 19ft 8in, are the same for all, while their inside diameters vary from 5ft 3in down to 4ft 10in, with corresponding increases in weight from 11 tonnes up to 17–18 tonnes. They were not manufactured *in situ*, but in a works specially equipped for the purpose by the Sociétés Réunies Everite Sitube. It was then necessary to transport them over a distance of 156 miles, of which 22 miles were by road, to their final emplacement. Each end of the pipes is provided with jointing rims, of cast iron for the lower pressures, and of steel for the higher pressures.

Each pipe consists of three elements. The inner pipe is made by centrifugal casting of the concrete. During this operation the ends of the pipe are rigidly constrained between parallel planes and steel reinforcement is stretched from end to end parallel to the centre line of the pipe. On the outside of the inner pipe coils of steel wire are strip-wound to form a reinforcement, which ensures a compression of the concrete at right angles to the axis throughout the thickness of the pipe. The degree of compression is dependent upon the inside pressure and the outside stresses to be resisted by the pipe, and is calculated to ensure that the concrete of the prestressed cylinder is never subjected to a tensile stress. Lastly, an exterior concrete layer is placed to cover and protect the steel coils. The jointing of any two prestressed concrete pipes is carried out by ordinary grooved spigot and socket joints with rubber gaskets.

The last piece of pipe immediately ahead of the power station is made of steel. This end piece was made of steel in order to avoid excavating the large-size tunnel, which would otherwise have been necessary to accommodate the concrete pipe. Such excavation would have considerably lengthened the period of construction. At each bend in the pipe-line a steel sleeve, cut *in situ* to the correct shape, and provided with a manhole, is inserted between the sections of prestressed concrete pipes.

The main advantages claimed for the prestressed concrete pipes are safety, on account of the high quality of the product; perfect tightness against leaks; resistance to internal pressure and vacuum, as well as against lengthwise and crosswise deflections; resistance to corrosion; adaptability to temperature variations; and overall flexibility of the pressure pipe-line. The use of these prestressed concrete pipes resulted in a saving of 560 tonnes of steel.[4]

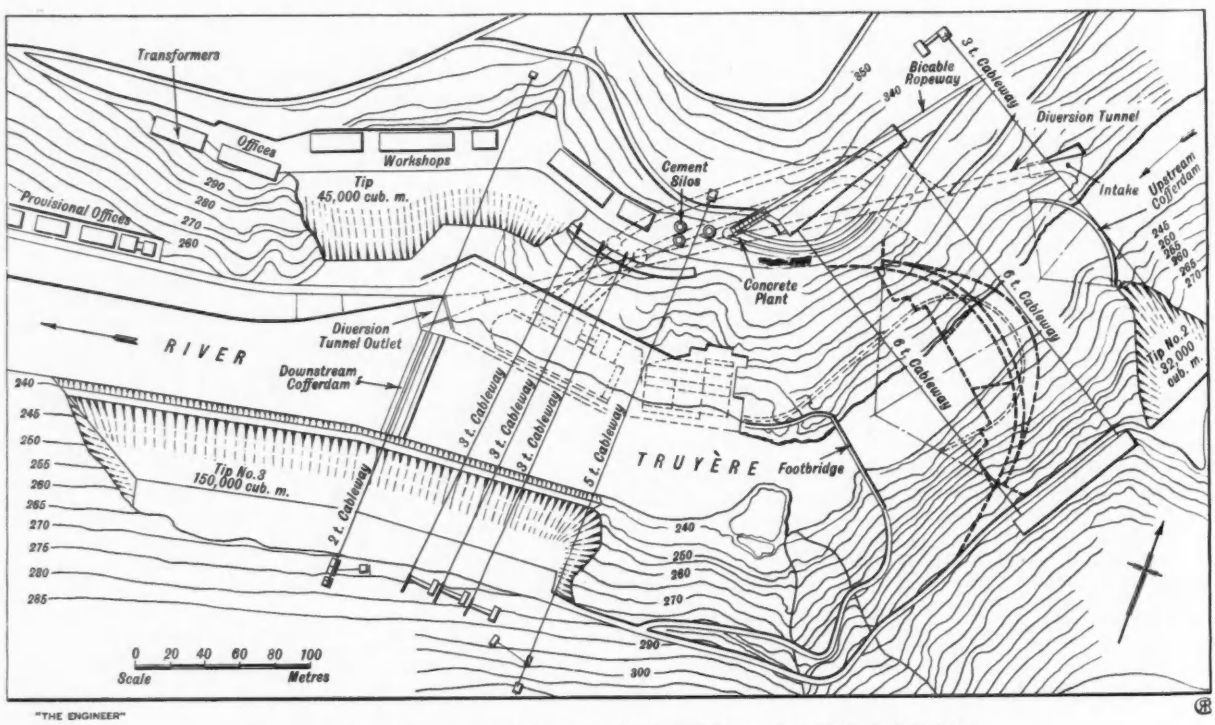


FIG. 18—PLANT FOR THE ERECTION OF COUESQUE DAM AND POWER STATION

THE LARDIT POWER STATION

The Lardit power station has an available power output of 50,000kVA and is provided with an outdoor 10/220-kV transformer

[4] *Travaux, loc. cit.*, page 48.

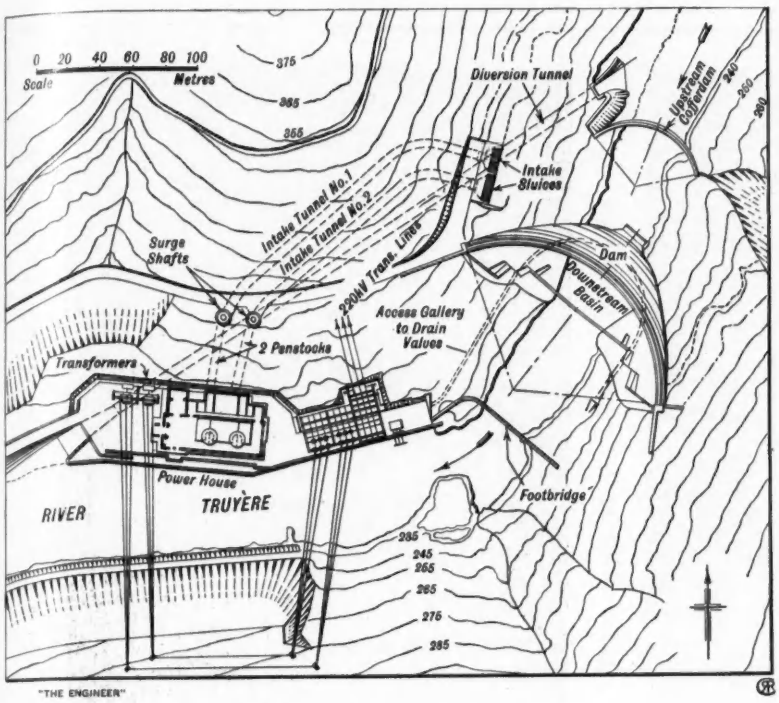


FIG. 19—COUESQUE PLANT—GENERAL LAYOUT

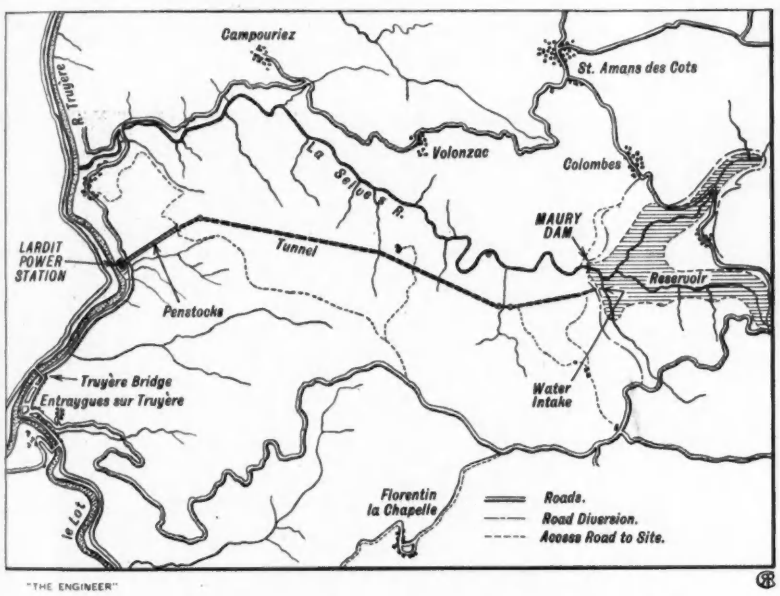


FIG. 20—MAP OF MAURY DAM AND LARDIT POWER STATION

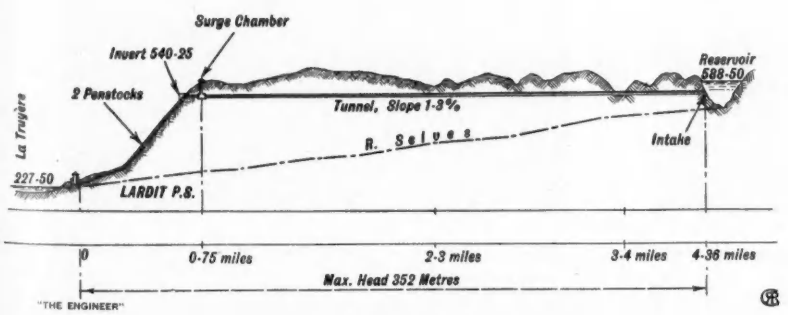


FIG. 21—PROFILE OF SELVES POWER PLANT

station. The two principal generating sets consist of Als-Thom alternators and Charmilles Francis type turbines, each of 30,050 h.p. at 750 r.p.m. These turbines are

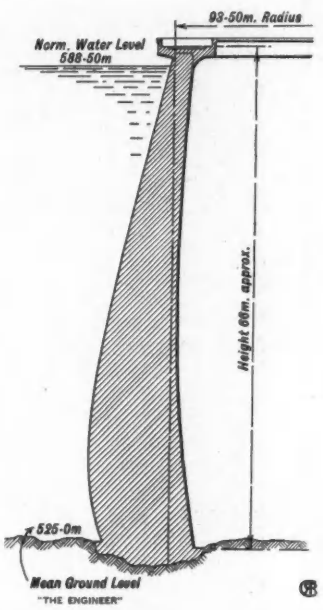


FIG. 22—SECTION THROUGH MAURY DAM

mounted on vertical shafts and drive 25,500-kVA, 10-kV alternators. There is one auxiliary set, a 1000 h.p. Pelton wheel running at 1000 r.p.m., and driving a 1200-kVA, 10-kV alternator.

Contrary to the practice usually adopted in the power stations of the district, the governors are mounted at alternator floor level and the turbine vanes are controlled by means of a vertical shaft. Each turbo-alternator set is provided with its own lubricating system for the automatic pressure

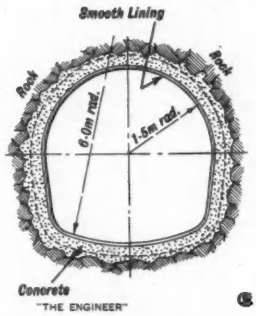


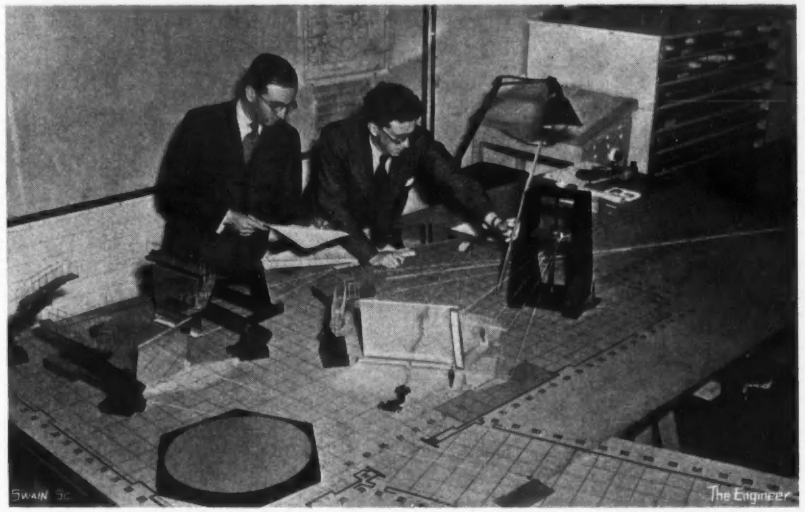
FIG. 23—SECTION THROUGH TUNNEL

lubrication of the pivot and guide bearings of turbine and alternator. The main valves on the turbine inlet pipes are not butterfly valves, but simple cock body valves, which have the advantage of offering an unrestricted section to the pipe flow.

Another feature of hydraulic character is the artificial raising of the level of the turbine tail-race by nearly 20ft. This loss in head, which entails an energy loss of 3 per cent, has been provided in order to be able to carry out, at some future date, a project for the construction of a weir across the Truyère. This weir would be situated immediately upstream of the mediæval (twelfth century) bridge of Entraygues.

(To be continued)

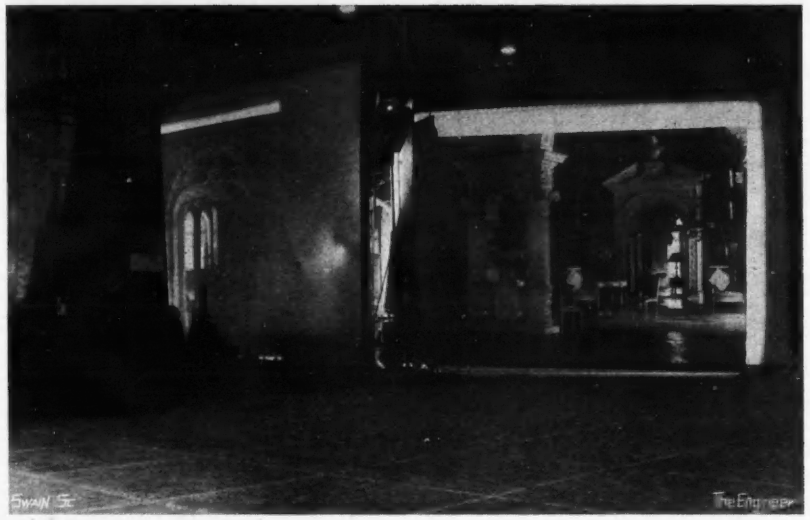
EQUIPMENT FOR "INDEPENDENT FRAME" FILMING



MODELS AND GRID FOR PLANNING POSITIONS OF UNITS

SCENE FROM A FILM WITH A PROJECTED BACKGROUND

ROSTRUM, SCREEN, CAMERA AND LIGHT BRIDGE SET UP



REVERSE SIDE OF PROJECTOR SCREENS

Equipment for "Independent Frame" Filming

DURING its comparatively short history the film has had the assistance of specialists in many fields. One of the latest to be called in is the engineer, to help the industry at a critical time to reduce its costs of production. The British film industry in particular has found it difficult to recover production expenses, because of a limited market for its films. In an endeavour to cut these costs a new method of production, known as "independent frame" technique, has recently been developed and used with considerable success. In connection with this method much heavy studio equipment is required, thus bringing in the skill of the engineer.

The introduction of independent frame technique to the British film industry owes much to the J. Arthur Rank organisation; in film language it was "sponsored" by that group. In 1946 the organisation's research department head, Mr. David Rawnsley, carried out a survey of studio methods with a view to cutting production expenses. He concluded that there was considerable scope for economy in the costs of running huge sound stages, representing a large capital investment. In the running of these stages delays in "shooting" are notorious, and keep highly paid directors, actors and technicians working on one film for many months. Mr. Rawnsley advocated efficient planning of production and speed in the use of sound stages by increase in the use of "back projection," upon which the independent frame technique is based.

Independent Frame Filming

"Back projection," the method whereby a scene is projected on to a translucent screen and the image is photographed from the reverse side of the screen, is by no means new. Since the earliest days of the cinema, scenes showing characters in trains or cars have been taken by using as a background a moving projection, the actors and camera being stationary in a mock-up of the train or car in the foreground. Independent frame technique has been evolved by making extensive use of back projections, and by combining a minimum of stage scenery and "props" with a maximum of previously photographed background.

But there is far more to the technique than the photographing of actors against projected backgrounds. Exact planning of the film is insisted upon, and a schedule of production is drawn up in detail. The positions and heights of scenery, camera and light bridges, the positions of back-projection projectors and screens, and even the camera lens and aperture are fixed in advance. This work entails the use of charts and tables, marked with a grid corresponding to a grid painted on the floor of the sound stage. By using the grid squares as co-ordinates, accurate references can be given for placing the equipment quickly on the day of shooting. An illustration, on page 222, shows how by the use of models and this grid, the positions of units may be planned, and a second illustration on that page reproduces a typical result as viewed in the cinema, in which the characters, desk, chairs and floor are photographed against a projected background.

Independent Frame Equipment

With independent frame filming economy in the use of the sound stage is gained by assembling the scenery in a shop on mobile rostrums or wheeled platforms, which can be elevated to the required height and when in position lowered off their wheels. The major lighting units are made in the form of wheeled bridges. Back projection projectors are mounted on self-propelled towers, with provision for elevating the projectors to the required height. The back-projection screen holders are also made in the form of mobile units. All this equipment can therefore be readily moved into position when required.

The third and fourth illustrations, on page 222, show some of these units in use. One of these views shows a rostrum, with partly-built foreground and a projection screen interlocked at the rear. The camera and microphone are to the right, in the "shooting" position. In the foreground is a mobile light bridge. The other illustration gives a closer view of the screen holder and two interlocking projection screens. In this view the camera position is beyond the screens and "shooting" on to them. The projection on to the screens in each of these two views has been partly "killed" owing to the intensity of the flash-light used in photographing the "stills" we reproduce.

Description of Equipment

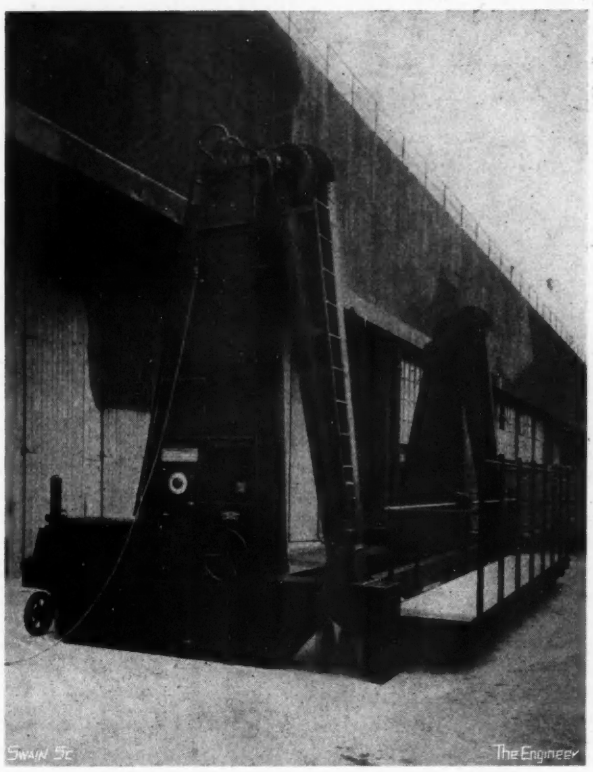
In designing the equipment stress was put on light weight and mobility. Another requirement was that mechanical noise and vibration in use should be kept to a minimum to avoid interference with rehearsals and in the case of one item—the hexagonal rotary stage—the requirement was that it should be entirely noiseless during use when recording dialogue.

The general design was roughed-out by Mr. David Rawnsley and developed by Mr. E. Ramsey Green, consulting engineer to the Rank Organisation. Orders for prototypes were placed with Robert Boby, Ltd. Production started at two of the works of Vickers-Armstrongs, Ltd., the projector towers being built at Vickers' Crayford works, and the other units at the firm's supermarine works at South Marston, near Swindon.

In general the materials used for structural members and panels are aluminium alloys and only about 1 per cent of steel was found necessary. Castings are of light alloy. Alloy steel and Meehanite are used for chain-sprockets and gearwheels. Following the firm's aircraft practice, most of the structural joint and panel faying surfaces are "made" with zinc chromate corrosion inhibitor.

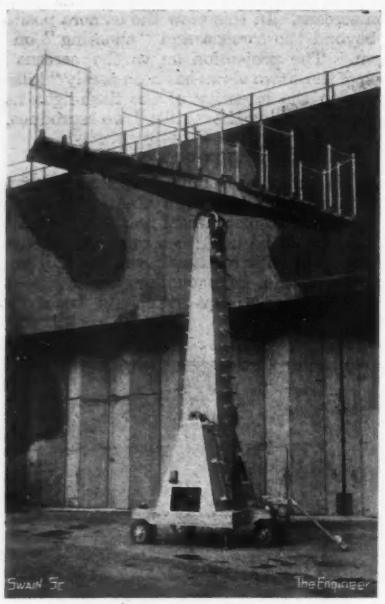
Screen Holders and Light Rails

Two accompanying illustrations show the construction of the combined back-projection screen holders and light rails. Each unit



Combined Screen Holder and Light Rail in Raised and Lowered Positions

has two luffing jibs, connected at the top by a box-form walkway. At the bottom the pylons are connected by a larger section box-beam. The complete unit is on wheels, which may be hydraulically raised or lowered. One illustration shows the screen holder and light rail almost at full elevation and the wheels lowered; the other the screen holder at minimum elevation and the whole unit resting on the ground.



Self-Propelled Light Bridge

The base structure houses a Metropolitan-Vickers electric motor, driving through a Stone's gearbox, universal-jointed shafts, and final worm reduction gears mounted at the top of each pylon. The casings of the final worm reduction gears provide bearings for the luffing-arm pivots. Elevation of the jibs is assisted by compression springs in each pylon, acting on the root of the luffing-arms through 2in pitch chain. Similar chains of 1¼in pitch anchored to the luffing-arm pivot shaft, maintain the walkway in a constantly level position, irrespective of the luffing-arm position. Luffing control is by two-station mechanically interlocked push-buttons, one at the centre of the walkway and the other on the outer face of the pylon at the control end of the unit. The luffing motion is limited both upwards and downwards by limit switches. Edge-illuminated height indicating dials are provided at both control stations. Power is supplied through a trailing cable connected to a 115-V d.c. source.

Arc light sockets are bolted to the main members of the walkway and in addition provision is made at the upper end of the walkway guard stanchions for a range of smaller arc lights. The translucent back-projection screens are hung in frames from the underside of the walkway. These screens are made in three sizes, 30ft by 24ft, 24ft by 18ft, and 18ft by 14ft.

The wheels can be rotated through 180 deg. and can be coupled for manual steering in confined spaces or the unit can be towed by a tractor. The vertical shafts on which the wheel-axles are mounted enter hydraulic cylinders, each supplied by one cylinder of a four-cylinder hydraulic metering pump, so that the whole structure can be lifted clear of the floor. It is said that the unit can be moved on the studio floor by four men.

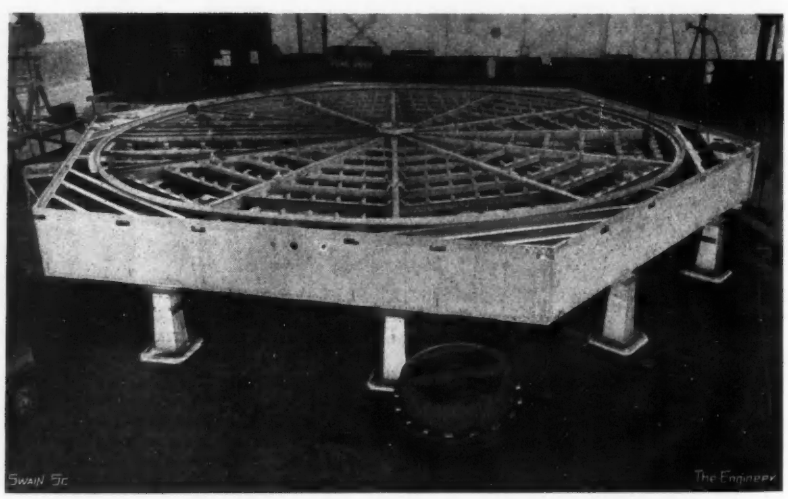
Self-Propelled Light Bridges

In some respects the design of the mobile light bridges is similar to that of the unit just described. Its construction can be followed by reference to the accompanying illustration. A single luffing-arm is mounted between two pylons on a rectangular box-section base. At the end of the arm is carried a platform, which can be rotated through a full circle, and is maintained horizontally, whatever the position of the arm. Outrigger or extension platforms are provided at the ends of the main platform and are hinged so that they can be rotated horizontally and locked in any position through 180 deg. By luffing the arm the platform is moved through an arc, which permits the upper surface to come within 3ft of the studio floor. The arm is over-balanced about its trunnions to the extent of half the 1500 lb load which the unit is designed to carry on the platform. Luffing of the jib is by a 115-V d.c. motor, driving through a 50 to 1 Opperman gearbox and chain gear to a final double helical pinion and gearwheel. The jib motor is contained within one of the trunnion pylons, and the control panel within the other. Dual push-button stations control the jib-luffing action and the traction motor.

The whole structure is mounted upon three sets of double wheels, the front set being driven and steerable, as shown in the illustration. The driven wheels are connected through a modified Ford differential gear and clutches to a reduction gearbox, and to a vertical spindle 115-V motor. This traction head can be turned through rather more than 180 deg. Control is by a "dead-man" handle, operating micro switches carrying relay current, mounted on a steering arm, and giving inching and full-speed control at 2½ m.p.h. The rear wheels can be turned by hand through 90 deg. for manœuvring in close quarters, and the whole unit can be turned about its vertical axis. Hand-operated jacks steady the structure when required. A height-indicating edge-illuminated dial is provided at the lower jib control push-button station.

Hexagonal Rotating Stage

A piece of equipment not so far mentioned is a rotating stage, with six sides, measuring 32ft across the flats, the whole structure being mobile and capable of being elevated to a maximum height of 10ft, or of being tilted at any desired angle within the limit set by the 10ft height. The hexagonal plan permits rectangular mobile rostrums, described below, to be placed closely. An accompanying illustration shows the stage under construction. The flush rotating table is 30ft in diameter, and is designed to accommodate a larger superimposed false stage when required. Provision is made on all six flats for drop-in interchangeable cantilever brackets supporting auxiliary outrigger platforms 8ft wide.



Hexagonal Rotating Stage under Construction

The whole stage is mounted upon three sets of wheels. Two of the axles, each carrying six solid-tyred wheels mounted on needle-roller bearings, are fixed, but the third axle, carrying four similar wheels, is steerable for towing or pushing. The steering axle assembly is shown in the foreground of our illustration.

Elevation and tilting of the stage is by a series of four reverse-toggle-action electro-hydraulic legs, each having four solid-tyred wheels at their outer ends. Hydraulic accumulators lift these legs clear of the ground when the stage is required to be moved from one position to another.

The stage itself can be rotated at any speed up to 20 r.p.m., the drive being taken through a central reduction gear from two d.c. motors, driving two six-start parallel worms engaging a common worm-wheel. Control is from a remote desk. All electrical equipment for the stage was supplied by the B.T-H. Company, Ltd.

It has already been mentioned that the mechanical noise level had to be unnoticeable during the recording of dialogue. This requirement was stipulated up to a speed of 6 r.p.m., and involved special design measures in silencing motors and bearings, and the resilient mounting of the track-wheels, supports, and rotating-table structure pin joints. The track on which the stage rolls is 30ft in diameter and is made from a special thick-flanged extruded "I"-section. It was machined to obtain an inverted conical track surface, and the resiliently-mounted track-wheel solid tyres were ground to obtain the corresponding cone angle. Resonance in the structure was damped with "rock wool," supported by perforated light alloy sheet on the underside of the rotating platform and on the internal surfaces of the hexagon flats. Timber decking is generally 1¾in seasoned British Columbia pine and is mounted on cork composition strip. All the joints were ploughed and tongued with a special diagonally laminated multi-ply hardwood. To guard against the possibility of creaks, the tongues and ploughed grooves were dressed before assembly with lanolin, and $\frac{1}{16}$in strips of Prestik were fitted between the abutting edges above and below the tongue.

Mobile Rostrums

One of our illustrations shows clearly the construction of mobile rostrums. These structures are of tubular construction and can be "made up" to any height up to 10ft. The base trolleys are of welded steel tubular construction, mounted on castering wheels. The "heighting gates" are also of welded steel tube construction.

The decking and measures for damping resonance are similar to those described above for the rotating stage, but since seasoned timber was not available, kiln-dried timber was used. This decking is mounted on light alloy "top-hat" drawn sections, supported by welded lattice girders. Removable guard-ropes and stanchions are provided round the deck edges, and means are furnished for clamping the rostrum closely to adjacent similar

rostrums, as required for the floor area of "set."

Projection Towers

The projection towers, built at Vickers-Armstrongs' Crayford works, can be described as self-propelled lifts for positioning the optical projectors, together with their operating crew. They are made in three types, 16ft and 30ft, each carrying two projectors, and a higher triple head for carrying a triple projector. Some particulars are given in the accompanying table, and a typical projection tower is illustrated herewith.

Whilst the 16ft and 30ft towers are steerable and can be moved to any desired point on the studio floor, the triple head tower is restricted to a fore and aft movement on a fixed rail track.

All the towers consist of a platform on which are mounted the projectors (the 30ft and triple-head tower platforms being counterbalanced), operating between two vertical frames, which are in turn attached to an undercarriage mounted on traction wheels driven by electric motors. In the case of the 16ft towers, elevation of the lift is effected by means of a hydraulic ram mounted in the undercarriage and transmitting motion to the platform through wire-rope reeving. On the 30ft and triple-head towers an electric motor, mounted in the undercarriage, transmits power through coupling shafts and gearboxes to roller chains operating on sprocket pulleys at the top and bottom of the vertical frames for hoisting or lowering the platform. Normal steering at right angles to the fore and aft lines is provided on the 16ft and 30ft towers, with further provision on the 16ft tower to allow normal steering fore and aft and also rotation of the structure about its central point. Steering in both cases is by means of hydraulic rams controlled through valves attached to a steering column on the driver's platform. The triple-head tower can be transferred from one track to another by bringing into use a set of hydraulically operated retractable wheels mounted at right angles to the fore and aft line of the tower and permitting the tower to be transferred to a track at right angles to the main track.

When the 16ft and 30ft towers are in the required position for action, their wheels can be lifted clear of the ground by four hydraulic jacks permanently fixed to the undercarriage, the jacks thus forming four rigid feet for the towers, as shown in our illustration. In addition, the lift platform can be rigidly clamped to the vertical frames by hand or hydraulically operated taper gibs in the case of the 30ft and triple-head towers, and by hydraulically operated snail cams for the 16ft towers. The platform clamps are in all cases electrically interlocked with the platform hoist control gear.

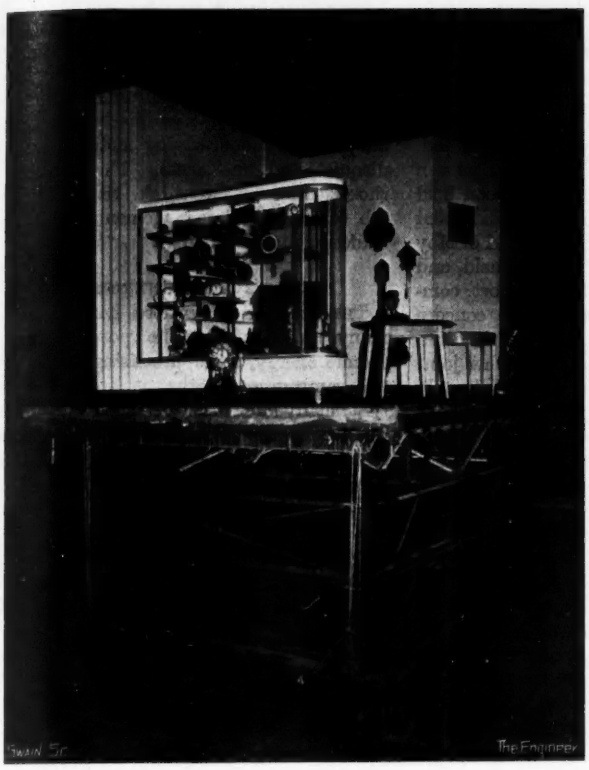
Power is supplied through trailing cables from a 110-V three-line d.c. supply from the studio overhead grid, an exception being the current for the traction motion in the triple-head tower, for which overhead trolley wires and pantograph collectors are fitted.

The towers are mainly of latticed frame construction and can be dismantled into sections for transportation from manufacturer to user.

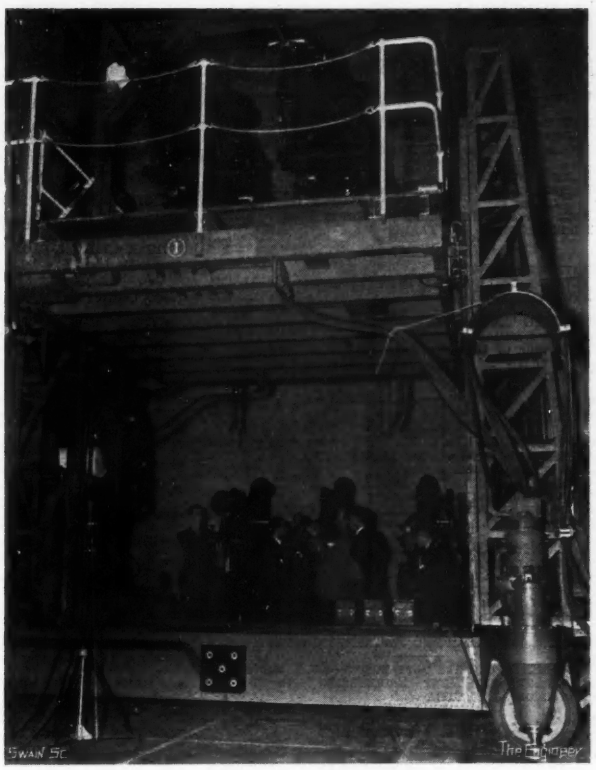
The first consideration in the design of the structure was to obtain rigidity of the lifting platform in all positions, achieved partly by the use of comparatively heavy sections, with a skin-plated undercarriage in the case of smaller towers and partly by great care in manufacture, particular attention being given to the welded and riveted joints to avoid distortion.

The platform for the projectors consists of a timber deck built on a system of steel beams, the transverse beams of the triple head tower being of fabricated box-section internally webbed, some 22ft in length and calling for a high degree of workmanship in construction.

The triple-head tower is fitted with gear for winding the projector on to the wooden platform. On the 16ft and 30ft towers part of the wooden decking is removable and the projectors can be wheeled into duralumin channel joists under the decking.



Mobile Rostrum



Projection Tower

Data for Projection Towers

	16ft Tower	30ft Tower	Triple Head Tower
Height of hoist platform above floor level ... Max.	11ft 11in	24ft 0in	26ft 7in
Height of hoist platform above floor level ... Min.	3ft 5in	4ft 7½in	4ft 7in.
Normal hoisting speed (alternative "inching" is provided)	5ft/min.	30ft/min.	22ft/min.
Permitted platform loading	6,300 lb	6,300 lb (min. 1,900 lb)	12,000 lb
Speed of traction	2 m.p.h.	2 m.p.h.	2 m.p.h.
Overall height	16ft 1in	34ft 4in	39ft 3in
Overall width	13ft 9in	17ft 7½in	22ft 0in
Overall length	21ft 8in	24ft 9in	35ft 0in
Approximate weight unladen	11 tons	23 tons	38 tons

Felt Works Centenary.—For 100 years the firm of D. Anderson and Son, Ltd., has been engaged in the manufacture of felt which has been applied to many kinds of industrial purposes, and to celebrate the centenary an attractive book has been produced which not only records the various stages of the company's progress, but also notes many outstanding events which have occurred since 1849. The firm was founded in that year by David Anderson at Lagan Felt Works, Belfast, and when in 1853 his son James joined the business, the principal product was tarred-flax felt. The business was carried on in Belfast for more than seventy years, the transfer to the company's present works at Stretford, Manchester, being made in 1921 and 1922. Detailed information about some of the firm's earlier years is lacking, probably on account of the fact that in June, 1889, the Belfast felt mill was gutted by fire. It is of interest to recall that in the nineteenth century, the danger of fire in such a mill was considerably greater than it is now. Then, the rollers on the felt machines were not heated by steam. Red-hot lumps of metal—heated on stoves near the machines—were thrown into the hollow rollers! Side by side with the company's production activities there has been developed a "contract" service, by which skilled men are engaged in the actual application of the felt manufactured. An early example of this side of the work is illustrated in the frontispiece of the book, and shows men fitting felt sheathings to the bottom of a Belfast-built ship in the year 1852.

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts: correspondents are therefore requested to keep copies.

For Subscription Rates, see page 2 of Advertisements.

THE T.U.C. AND PRODUCTIVITY

FOR many months now industrial life has been highly coloured with exhortations to greater productivity, and it is not at all surprising, therefore, that the General Council —which is the "Cabinet"—of the T.U.C. has devoted a good deal of space to that subject in its report published earlier this week. It is, we feel, to that part of the document which is particularly concerned with productivity that the engineering industry should give special attention, rather than to other parts whose contents traverse ground more familiar in trade union affairs. For it presents an account of what the T.U.C. has attempted and just how much—or how little!—it has achieved during the past twelve months by its efforts to emphasise the necessity for greater industrial productivity.

Following a resolution of last year's Congress, a conference of executives of affiliated unions was held to consider ways and means by which the level of productivity throughout British industry could be raised. At that conference, it was pointed out, amongst other matters, that the uneconomic and wasteful use of labour was a factor impeding maximum production, that under-employment in certain industries might involve the transfer of union membership and the adoption of measures which might not be universally popular, and that such matters as "restrictive practices" and problems involving traditional union policy should be carefully examined. In addition, it was urged that more attention should be given to the study of production techniques, and that greater enthusiasm should be aroused for the formation of joint production committees and similar consultative machinery. As an outcome of the conference it was decided that the T.U.C. Production Committee should meet individual unions or federations of unions to discuss with them the productivity problems existing in the various industries which they represented. For a start, invitations were sent to eleven unions, and the first meeting was soon held with the Confederation of Shipbuilding and Engineering Unions. But by the end of May only three such meetings had been held, and the General Council's present report comments that "disappointment and concern was expressed (by the T.U.C.) at the difficulties experienced in arranging further joint conferences." Even by the end of July only four more conferences had taken place, which meant, the report observes, that "only seven unions or federations out of the first eleven approached had found it possible to discuss their problems with the General Council." Reading between the lines, as we study this part of the report, we cannot escape the conclusion that the T.U.C.—like many individuals and organisations closely associated with British industry—is experiencing perplexity and frustration as a consequence of the somewhat lukewarm attitude on the part of its constituent members towards increase of productivity. That view is strengthened by the General Council's summing up of these productivity conferences. While discussion at each conference was related to the particular characteristics of individual industries, there were "certain aspects common to most of them." It was revealed, for instance, that "where redundancy might not lead to re-employment except at a distance, there was considerable fear of unemployment, and a consequent reluctance to participate in measures to increase productivity." Again, the report continues, "on production techniques, such as motion study and redeployment and the attitude to industrial consultants, opinions were divided. The fear of redundancy as a result of new methods was an overriding consideration." The expression of those "fears" is a fairly plain indication that not a few trade unions still cling tenaciously to traditions of past days.

To the ordinary workman in the shop the new machine or the new method is still, in fact, something of which to be afraid. It is true, and workmen would probably admit it, that the course of industrial development over the last two centuries has shown that improved machines cause increased employment in the longer run. But it is equally true and somewhat more relevant to the individual workman that new machinery may throw certain men temporarily out of work. How, then, is a trade union to determine its policy? Individually its members may suffer through the development of new productive methods; as a group they will benefit. It is easy for those outside the trade union movement to say that the good of the greatest number should prevail. But it is very much more difficult for trade union leaders to follow a course of action individually unwelcome to their followers even if it is fully appreciated, as it may not be, that the traditional hostility of the working man to new machinery is out of place in a country whose economy is as severely strained as that of Britain. The T.U.C. is thus much to be commended for its attempts to encourage its constituent unions to change their views. But the T.U.C. report shows that it will be long before the individual members of unions will watch the installation of new machinery or the adoption of labour-saving methods without disquiet and uneasiness. The quieting of those fears must, we think, be as much the job of individual managements as it is of trade union leadership.

ATOMIC ENERGY

THE public everywhere have heard so many stories about the potentialities of atomic energy, some promising much good and some great ill, that it is small wonder that many are puzzled. Not only is the quality of the prophesied ultimate consequence so varied but the very time-table itself. Many were recently led to believe that a huge new bountiful supply of energy was just round the corner and might come almost at once to comfort a distracted world with greater facilities for easy transportation by land, sea and air as well as by providing cheap, easy power for any process of manufacture. Disappointed in this and fearful of dire effects in uncontrolled warfare, it is not astonishing that some should express themselves as unhopefully as the correspondent whose letter is published in this current issue. In his view it is only now that it is being realised that, for technical reasons associated with the high cost of uranium and its scarcity, neither locomotives, nor aircraft, nor even stationary power plants, nor ships, can be run by this means. He suggests that present activity is confined to the supply of a very few atomic bombs, with a certain modicum of radio-active material for medical purposes; larger supplies being impossible because the supply of uranium is so pitifully small.

The actual position is very different. In the latest half-yearly report of the U.S. Atomic Energy Commission it is stated that American survey has revealed the presence of abundant supplies of low-grade uranium ore, and that although such ores may be more costly to process than the richer ones, the quantity available will suffice to maintain America's military programme. This is not really so surprising in view of the estimate given in last year's Chatham House report by its Atomic Survey Study Group that the total amount of uranium in the upper mile or two of the earth's surface runs to millions of millions of tons (in addition to perhaps three times as much thorium). It is true that the size of America's present stock-pile of atom bombs has not been officially disclosed, but that it is certainly substantial can be readily inferred from the immense political influence it exerts on world affairs. Moreover, the scale of production is known to be so large as to lead to the existence of radio-active waste products in quantities which are proving to be no little embarrassment to

those that have to dispose of them. It may, it is true, be long before atomic fuel can be efficiently used for aircraft propulsion, though it is known that the Fairchild organisation in U.S.A. has the problem in hand. The corresponding development for ships should prove far simpler since limitations in space and weight are much easier, and the water surround can act as a useful shield. Electric generating stations on land are expected to present the least difficult of these problems, and as cautious a scientific leader as Sir John Cockcroft, the Head of the Harwell research establishment, feels able to forecast the existence of such experimental power stations within the next few years; adding that the present energy consumption of the world could be met by the complete fission of as little as 250 tons of uranium a year. The suggestion made by our correspondent that the new fuel must cost so much to prepare that, apart from medical uses, the proposition is useless commercially can only be shown to be wrong by producing it at a price at least comparable with that of existing sources of mechanical power. That may take time but in the meanwhile we have at least the fact that in the U.S. Atomic Energy Commission's report of a year ago it was felt safe to say that if the present effort to build breeding reactors meets with success it should be possible, with uranium costs at their present level, to create a new fuel industry greater than that associated with coal, and at a lower selling cost.

Apart from the many efforts on the civil side, and whether they succeed or not, one must not forget that a material factor in the balance of world power, in the political sense of the phrase, is the existence of the atomic bomb in the U.S.A. arsenals. So high an authority in such affairs as Mr. Churchill has not hesitated to place high importance on this factor in his assessment of the present balance between East and West; is it reasonable for such a high issue to be described by our correspondent as resting "on the most insecure of premises"? We think that most of our readers will agree with our view that it is not.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

TECHNICAL SCHOOLS

SIR,—Under the new Education Act children are supposed to be given an education according to their age, (mental) aptitude and ability. In the past the only 11+pupils who have been adequately educated are those who passed the "scholarship" examination and won a place into the secondary (now called grammar) schools. A few others, if lucky, could go to technical schools. The grammar schools, over fifty years, have built up a very high tradition, and we all hope it will be maintained. But the technical schools have never attained the same status because they were never given the same amenities. The number of technical places, moreover, was only a fraction of the grammar school places. The teachers and professors concentrated on the grammar schools because eventually the pupils entered the universities and gained degrees and reflected flattering glory on their "good" teaching. The technical schools were a very much "second best," especially in Wales, where the chief export of the distressed areas was teachers, preachers and Civil Servants. No wonder we were inundated with unemployment. We were producing no technicians and engineers to start new or ancillary industries. We are now beginning to understand the errors of our ways. We are at last recognising we have been misdirected by the educational pedagogues. Even the teachers were blameworthy, but primary school teachers are so academically trained that they cannot be expected to be practical minded.

There was another reason why technical schools were neglected. Education committees have not been business minded and have thought (quite wrongly) that it was playing into the hands of our captains of industry to prepare trained technicians for them. They forgot that our whole existence depended upon production—qualitative as well as quantitative. Teachers and professors, too, decried vocational education and repeated such silly slogans as "selling the children to the capitalists" *ad nauseum*. They treated industry as an enemy instead of a friend, and so as regards the provision of technical education we have to-day such leeway to make up. Building schools though is a shockingly slow and terribly costly proposition, but I do hope junior technical schools will have priority. The basis of the standard of living for a population of 47,000,000 Britishers depends upon the highest technical efficiency. We need to increase technical school places from 72,000 to 100,000 at least as soon as we possibly can, and see also that these schools have first-class teachers and equipment and amenities so that parents are just as glad to send their children to them as to the much-respected grammar schools. Industry, moreover, should surely have a fair proportion of Britain's best brains. Other countries (Germany pre-war, in particular) do show industrial awareness, and a pride in production. We dare not lag behind.

EDWIN WILLIAMS,
B.Sc. (London), F.R.G.S., M.R.S.T.
Headmaster, Rogerstone County School.
Monmouthshire, August 15th.

ATOMIC RESEARCH

SIR,—The writer has become increasingly alarmed as time has gone on in connection with what benefits the public believes will accrue from the astronomical sums of money being poured out on atomic research. Very little of the truth seems to be seeping through, i.e., that aeroplanes and motor-cars cannot be run by these means for technical reasons, neither can locomotives, factory engines or ships and the like, due to the enormous cost and meagre supply. The whole matter is, as far as can be seen at present, confined to the supply of a very few atomic bombs and radioactive material for medical purposes. In fact, the supply will not run to both, as it is pitifully limited.

It would appear that huge research stations and staffs are being built up and gigantic sums poured out on the most insecure premises. They are beginning to tumble to these things in America, and it seems high time that something was inquired into here. The two outstanding points are that there is no supply of raw material worth mentioning and if there were it costs so much to prepare that apart from medical uses the proposition is useless commercially.

CHARLES BAXTER, M.I. Mech. E.,
M.I. Mar. E., M.I. Loco. E., &c.
London, N.W.6, July 23rd.

BEHAVIOUR OF CAST STEEL AT "ELEVATED" TEMPERATURES

SIR,—In reply to Mr. A. B. Scorer's letter, I submit that there is a difference in meaning between "high" and "elevated." Any temperature is high in relation to a lower temperature, but I understand "elevated temperature" to mean raised above the normal maximum temperature. Behaviour of carbon steel "at high temperatures" might mean at 200 deg., 300 deg. or 400 deg. Cent., but "at elevated temperatures," I understand to mean at a temperature raised above the maximum temperature it will normally withstand, e.g., in the case of carbon steel about 400 deg. Cent. Creep at the "high" temperature of 250 deg. Cent. does not exist but it takes place at *any* "elevated" temperature. How Hi is a Chinaman.

D. V. ONSLOW,
August 19th. Information Officer.
The British Electrical and Allied Industries Research Association, Leatherhead, Surrey.

Long-Distance Telephone Project in Eire

NEW trunk telephone circuits between the main centres in Eire, using modern high-frequency coaxial telephone cable, and terminal and repeated equipment, will be installed by Standard Telephones and Cables, Ltd., Connaught House, Aldwych, W.C.2, on behalf of the Department of Posts and Telegraphs.

A cable consisting of two coaxial "tubes," surrounded by a number of pairs of wires for operation at voice frequency, will be laid from Dublin to Cork via Port Laoighise and Limerick, with a branch to Waterford. The frequency band which will be available on this cable will permit of a maximum of 600 circuits on the coaxial tubes, exclusive of voice frequency circuits provided by the surrounding pairs. Terminal equipment for the translation of the voice frequency switchboard connections to the required positions in the frequency spectrum of the cable will be installed at all of the above centres. In this terminal equipment the long-distance circuits from the switchboard are first grouped in sets of twelve, then five groups of twelve circuits are combined into one "supergroup" of sixty circuits. Finally, the supergroups of sixty circuits are translated to their appropriate frequency bands on the cable.

Interconnection between succeeding sections of the cable will be effected by routing the circuits in blocks of sixty or twelve, so that, for through circuits, there will be no need to bring the incoming channels of communication down to voice frequency. The most heavily loaded section of the route will be between Dublin and Port Laoighise, where a total of six supergroups will be working initially, giving some 300 circuits. Of these some will be routed through Limerick to Cork, others will terminate in Limerick, and some will be branched off at Port Laoighise to Waterford.

Screened pairs for broadcast transmissions will be provided in all sections of the new cable, including a branch which will run from Port Laoighise to Athlone. This branch will not be provided with coaxial "tubes," but will comprise a number of pairs of wires for operation at voice frequency. The voice frequency circuits surrounding the coaxial "tubes" on the main cable are intended for connection to towns on the route between the main centres, providing additional telephone circuits.

Use will be made of the new technique for mounting line transmission equipment introduced by Standard Telephones and Cables, Ltd., since the end of the war. By the extensive use of miniature components the space occupied has been reduced in some cases to quarter; by the use of jack-in apparatus panels maintenance work is greatly facilitated, and the enclosure of a large part of the circuit elements in sealed containers has provided better protection against tropical conditions.

For some years part of the trunk telephone system in Eire has been equipped with a modern system of long-distance dialling, developed and installed by the same company. This system permits a provincial operator to set up a call to a Dublin subscriber without the intervention of an operator in Dublin. The new contract includes the provision of similar facilities, on the circuits to be provided by the new cable.

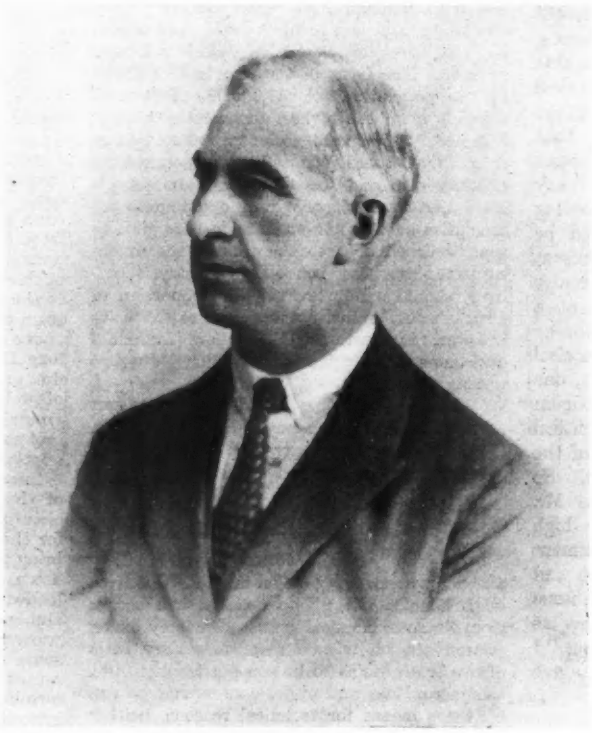
Obituary

GEORGE STEPHEN BAKER

LAST week we recorded briefly and with deep regret the death on August 16th of Dr. George Stephen Baker, O.B.E., first Superintendent of the William Froude laboratory. Dr. Baker was born at Rochester in 1877 and entered the Royal Dockyard, Portsmouth, as a shipwright apprentice in 1892. For outstanding ability he was selected by the Admiralty to continue his training at the R.N. Engineering College, Keyham, in 1896, and a year later he went to the R.N. College, Greenwich, as a probationary assistant constructor. In 1900 he graduated from that College with a first-class professional certificate. He joined the Royal Corps of Naval Constructors and was employed for a short time at the Admiralty, Whitehall. He was then appointed assistant to Mr. R. E. Froude, the Superintendent of the Admiralty Experiment Works at Haslar, and it was during the five years Mr. Baker spent at that establishment that he first practised ships' model experiment work of the kind that later became his life's work. His next appointment was that of professional secretary to Sir Philip Watts, who was then the Director of Naval Construction. It was while he was with Sir Philip that, in 1908, the Royal Society decided to establish a laboratory for the practical study of hydrodynamics as applied to merchant ships, and through the munificence of the late Sir Alfred Yarrow, a large ship model experiment tank was constructed at the National Physical Laboratory, Teddington. In March, 1910, Mr. Baker was selected as the man most competent to supervise the construction of this new laboratory and to superintend its work. The William Froude Laboratory, thus created, commenced its work in July, 1911, when its equipment consisted of one large and one small tank. In 1932, a second large tank was constructed, and in 1935, as a gift from Sir James Lithgow, a propeller tunnel was added to its equipment. From 1911 until his retirement under the age limit, Dr. Baker initiated, organised and carried out a very large programme of researches, which involved the making of hundreds of ship models and propellers, and the carrying out of hundreds of thousands of experiments. These researches included fundamental work on skin friction, wake and propeller design. He did pioneer researches into steering, rolling and rough water, which he organised and carried out with great success, and it was as early as 1912 that he initiated the first model experiment researches ever made on seaplanes. This latter research was so successful that the Air Ministry made increasing use of the tanks, until in 1925 a tank specially designed for seaplane work had to be laid down at Farnborough to prevent seaplanes crowding out merchant ship work at Teddington. In addition to all this work, many thousands of models of particular ships were made and tested and their lines improved before construction commenced. This work was carried out for shipbuilders and shipowners at home and abroad. As greater knowledge was acquired, very large reductions in the fuel required to propel merchant ships followed as a direct consequence of Dr. Baker's skill, amounting in the aggregate to millions of tons per annum. But Dr. Baker was never satisfied with model experiment work alone. He quickly gained the confidence of shipowners and builders, and persuaded them to collaborate with the Laboratory in securing accurate data of ship performances on trial and in service. Although Dr. Baker did so much fundamental research, yet he gave priority to those researches which would be used in the immediate future, and by keeping in close personal touch with the shipping community and paying close attention to their needs, he so ordered the sequence of researches at the laboratory that his experimental knowledge was almost always one jump ahead of new developments in shipping, and his advice at the designers' service before it was required. So successful was Dr. Baker in his predictions from model experimental data to ship performance that it has become ordinary practice for the last twenty-five years to "tank test" all new ships of importance. To cope with the resulting great increase of tank experiment work occasioned by Dr. Baker's success, many tanks have been built in Europe, Asia and America, in which his methods are largely followed.

After relinquishing his post as Superintendent in 1942, Dr. Baker remained on the staff of the laboratory until the end of the war, carrying out special researches. From 1945 until his death, he devoted his time to research for the British Shipbuilding Research Association.

Within a few years of his taking up his duties at the William Froude Laboratory, Dr. Baker became a recognised authority on all matters dealing with the propulsion of ships, and he acted as expert witness in cases of dispute and served on numerous committees, where his technical knowledge and ability invariably commanded respect. During his career at Teddington, Dr. Baker wrote three technical books on ship form, resistance and propulsion, and read forty-three papers of high technical merit before different societies. He was awarded gold medals from each of three technical societies concerned with improvements in ship design. In 1935 he was made a Doctor of Science of Durham University, and he was also a Vice-President of the Institution of Naval Architects. For his extremely timely and valuable work on urgent problems during the 1914–18 war, he twice received the thanks of the Admiralty and was awarded the O.B.E. He worked unremittingly during those four years, without holiday or even week-ends, ingeniously adapting the equipment of the William Froude Laboratory to the strange and peculiar needs of the Admiralty, brought into existence by new methods of warfare.



GEORGE STEPHEN BAKER

Dr. Baker possessed a strong personality and his clear thinking, common sense and foresight inspired confidence in all those who worked with him. Perhaps his outstanding characteristic was a passion for the truth—a most valuable trait in any experimenter — and hypocrisy in any form received his bluntest condemnation. No trouble was too great and no obstacle too difficult for him to attack with unflagging energy and zeal in pursuit of knowledge. His drive and industry were enormous, and to follow up a full day's work by working far into the night was a commonplace with him, as his hours of work per week had no limit. He had no sympathy with slackness, yet he was extremely tolerant of genuinely made mistakes by those who worked for him. He was a very kindly man at heart, ever ready to give freely his vigorous help to those in trouble, following it up with good advice or caustic criticism as the occasion warranted. He delighted to delve into the past technical history of ships. Although his time was so fully occupied that he was prevented from indulging in his early love of sailing small craft, he always followed yacht racing with keen interest and would criticise a failure or applaud a good performance, which his great technical knowledge enabled him to appreciate to the full.

Dr. Baker had the ability to put shy people at their ease, gain their confidence, and extract from them the knowledge he required on very short acquaintance. He enjoyed a good joke and had a puckish sense of humour, which might have led a lesser man into trouble. His greatest joy in life was to carry out successfully a piece of work which most authorities said was impossible of accomplishment.

It is true to say that Dr. Baker's life was spent in the service of all who use ships, and his work will live for as long as ships exist; for those who build them will use the results of his researches long after all who knew him in the flesh have passed away.

New Weapons and New Tactics

(By Our Naval Correspondent)

MANY of the United States, Dutch and British pilots who took part in the recent air exercise over Great Britain were old friends who had worked together during World War II. It was thus possible to take co-operation for granted and to use the aircraft of the three Powers to investigate a war problem of the highest importance to all the nations who signed the Atlantic Pact—the extent to which jet fighters and modern radar installations have improved the air defences of this country. On the other hand, the circumstances were wholly different in the naval exercise which followed it. This was carried out by the navies of the Brussels Treaty Powers, who were gathered together for the first time. A very large percentage of the ships' companies of all the four navies were post-war entries and the first essential was to try and overcome the language difficulty by exercising communications in harbour. Subsequently manœuvres and exercises of real practical value were carried out in the Channel and Bay of Biscay, but the main object was to practise working together as a team.

Co-operation is, however, the least of the difficulties facing the navies of the Western Nations to-day, for co-operation can and will be achieved by further exercises of this nature and by standardisation as far as possible of equipment and organisation. The more important problems requiring solution are of a technical nature and may be defined as the effect of the atomic missile on naval warfare, the menace presented by the greatly increased mobility of the modern submarine when submerged, and, lastly, the part to be played by the aircraft carrier in the wars of the future. To some extent all three problems depend for their solution on research and development now in progress, but as they have only been briefly referred to in this journal, it would be well to discuss them in greater detail so that their nature and extent may be understood by all who value the safety of their country.

It is impossible to exaggerate the appalling effects of an atom bomb explosion, particularly the death-dealing gamma rays which will contaminate the surrounding area for days and even weeks. Fortunately, however, ships at sea are able to take full advantage of the only safeguard—which is to be outside the area affected by the explosion. The Bikini tests showed that, in both the above-water and under-water explosions, ships more than a mile away suffered no damage, either to material or to exposed personnel. Thus, instead of cruising in close order two or three cables apart, valuable or important ships will in future have to cruise a mile or more apart—which presents no difficulty in view of the vastness of the ocean. One vessel may then be sunk or put out of action, but the remaining ships —whether of a task force or of a convoy— will still carry on with their job.

The chances of survival of a ship which has been missed by an atomic missile but is within range of the explosion in the air or under the sea have yet to be ascertained. The old cruiser, "Arethusa," is now being used for this investigation, a source of radiation being directed on to her from pontoons moored in the vicinity, and it is hoped to discover from these trials to what extent gamma rays will penetrate into a ship. Another essential is to redesign and strengthen the superstructures and other exposed portions of our new ships to ensure that they have the best possible chance of standing up to the heavy blast. Dockyards and main naval bases in this country will also need to be safeguarded, but their protection is all part of the larger question of the air defences of Great Britain and the ability of this country to stand up to atom bombs. Fortunately, there is less need to worry about the safety of advanced bases in the operational area in view of the development of the fleet train. Finally, the atomic missile means a large addition to the number of escort vessels which have been required hitherto, since ships cruising a mile apart will each require their own quota of escort vessels. This in turn greatly increases the difficulty in solving our second problem —how to deal with the modern submarine.

If it is understood on what principles the construction of submarines has been based up to and including World War II, there will be no difficulty in understanding why the modern submarine is a very much greater menace than her predecessors. Up to date, the submarine has normally been of 800 to 1000 tons surface displacement, propelled on the surface by two diesel engines giving speeds of from 12 to 16 knots, and with electric motors for propulsion submerged. The storage batteries when fully charged would last about thirty-six hours at the diving patrol speed of 1½ knots, but rather less than an hour at a maximum submerged speed of 9 or 10 knots. Larger submarines, such as the "Thames" class, were built with more powerful diesel engines, giving a surface speed of 21 knots, to enable them to cruise with the fleet. But their size and length made them unhandy submerged and a relatively easy target for asdics—the supersonic device used for the detection of submarines submerged. Even within the limits of average displacement, however, the characteristics of the submarine could be varied as desired—submerged mobility could be increased at the sacrifice of surface mobility and vice-versa.

Thus, during the 1914–18 war, we found that our submarines on patrol submerged would often sight a U-boat on the surface, a short distance away, proceeding at 10 knots but on a course away, which made it quite impossible for the British submarine while remaining submerged to chase the U-boat and get into position for firing her torpedo. We therefore built a special kind of submarine—the "R" class—for the specific purpose of dealing with this situation. She had a small diesel engine, giving her a surface speed of only 6½ or 7 knots, but a very large battery which enabled her to proceed submerged at 15 knots for about an hour—for as long as was required, in fact. In that connection, however, it must be realised that the diesel engine installed in British submarines of those days were heavy and small with cylinders of only 100 h.p. If a modern engine had been installed in the old "R" class submarine, her surface speed would have been more like 10 knots or even 12 knots.

Apart from this special requirement of the 1914–18 war, submarine development right up to the last years of the recent war had been mainly in the direction of increased surface mobility, increased torpedo armament, and a stronger hull to permit of submerging to greater depths. With a general purpose submarine it was recognised that no more than 10 knots could be obtained when submerged and when endeavouring to intercept a target. Then came the "Snorkel"—or "Snort," as the British and American improved version is now called. This was originally a Dutch invention but was later developed by the Germans and fitted in their U-boats in the latter years of the recent war. It consists of a hollow tube, which can be raised above the surface as required, thus providing air for the diesel engines (and for the crew) when the submarine is fully submerged. Like the periscope, it can only be seen by surface vessels or aircraft when they are close to it—at a distance of perhaps 1½ to 2 miles in a calm sea—and it is almost impossible for radar to locate it. The Germans were quick to realise that this innovation, if fitted in a well streamlined development of the old British "R" class, would enormously increase the offensive and defensive capabilities of the U-boat. And by the end of the war, "Snorkel"-fitted U-boats, well streamlined to reduce resistance to submerged propulsion and with a large battery, were in commission. They could maintain a submerged speed of 17 knots for between half an hour and an hour before the battery was exhausted; and, of course, at lesser speeds, such as 10 to 12 knots, the battery would last three to four hours.

From the anti-submarine point of view there are three important points to keep in mind in connection with this "Snorkel"-streamlined-large battery combination. It is much more difficult for the surface vessel to maintain asdic contact with the submarine, because the asdic apparatus is not so efficient at high speeds. Secondly, if the submarine can succeed in evading the A/S vessels, she is in the happy position of being able to rise to "Snorkel depth" and proceed on her diesel engines (recharging at the same time her nearly exhausted battery) as long as the nearest enemy surface vessel is not less than 3 miles to 4 miles away. Thirdly, in the actual operation of "killing" a submarine, anti-submarine vessels require to use much higher speeds than the speed of the submarine. Our 21-knot wartime frigates would thus have no option but to endeavour to maintain contact for the best part of an hour before attempting the "kill."

But, quite apart from the speed aspect, the "Snort" or "Snorkel," is of the utmost value to a submarine for the following reasons:—

(1) She can remain permanently submerged from the time of leaving harbour until her return, a month or six weeks later.

(2) She need no longer come to the surface at night to charge batteries, at the risk of destruction by aircraft or surface vessels.

(3) She is practically immune from detection by aircraft unless overhead in a flat, calm sea.

(4) When a convoy or other target is reported, perhaps 100 miles away, she can proceed submerged, with little fear of detection, at the highest speed her diesel engines will give her, until within a few miles of the target.

Menacing as this modern submarine is, the Western Navies are likely to be faced with a much more dangerous type in the near future. The Germans, both before and during the recent war, had been experimenting with a Walter cycle engine for submerged propulsion and U-boat type "XXVI" with this engine was practically ready by the end of the war. Hydrogen

peroxide is used as oxidant for fuel, and air is not required for running the engine. This submarine is thus a realistic approach to Jules Verne's true submersible: a submarine that can be operated entirely submerged and remain submerged at 100ft, 200ft, 300ft—or any depth desired—for indefinite periods. The speed claimed for a submarine with this engine is 26 knots, which would mean that there is no anti-submarine vessel, other than a destroyer, which could hope to deal with her. Indeed, the question arises whether asdic contact could be maintained at all at that speed. And as all the Allies—including the Russians—had access to this new type, we may expect that she will be fully exploited. It must be added, however, that hydrogen peroxide is at the moment very expensive and its use will no doubt be limited for that reason to periods when high submerged speed at depths below periscope depth is required. For making a passage, or at other times when it is safe to use the "Snort," a diesel engine and "Snort" will no doubt be used.

What then is the actual state of affairs to-day? What progress has been made since the war in developing the "Snort"-streamlined - large battery submarines, and the hydrogen peroxide type? The Russians are believed to have between 250 and 300 submarines. They have shared in the division of German submarines and have, in addition, removed large quantities of prefabricated parts of submarines to Russia. They have also dismantled and removed to Russia entire submarine construction plants and factories. And they have in their employment German scientists and submarine designers and engineers. We may therefore assume that, as far as their workmanship and engineering skill permit, they are not behind Britain or the U.S.A. in submarine development.

Little or no information is forthcoming from British official sources regarding developments in this country, beyond the recent statement by the First Lord of the Admiralty that, while the submarine with fast underwater speed will be one of the greatest menaces at sea in the future, he knew of no existing submarine which does more than 20 knots submerged. The U.S. Navy Department, however, are not so reticent. On the contrary, they have issued a good deal of information on the subject. Already twenty-one of their submarines have been fitted with the "Snort," and their hulls streamlined by reducing the size of the superstructure; deck guns and guard rails have also been removed to reduce underwater resistance. Submarines under construction have been altered in design to take large batteries on the German model. Entitled the "Guppy" programme, these submarines "are the first of a series of basic steps in the Navy's long-range plans for designing and constructing the true submersible" and, it is added, "their operations will provide useful information for perfecting plans for the two new experimental submarines authorised by Congress."

There have been unofficial reports that these two new submarines are to be fitted with a hydrogen peroxide engine giving a speed submerged of 25 knots, but the reports are not corroborated from official sources. Officials state that the Walter cycle engine using hydrogen peroxide fuel is still in the experimental stage at Annapolis experimental laboratories, and has not yet been installed in a submarine. One notes, however, that over £10 million has been voted for the construction and completion of these two submarines, which seems an immense sum, even allowing for to-day's higher costs, for two submarines of existing types, when one remembers that our 35,000-ton battleship, "Nelson," completed in 1927, cost no more than £7½ million.

In any event, whatever the possibilities of the hydrogen peroxide engine, the submarine with submerged speeds of anything up to 20 knots is already upon us and the first essential is for the Western Powers to build large numbers of anti-submarine vessels with speeds of over 30 knots to cater for the present and early future. Not destroyers, for they are required for many other duties in war and they are much too heavily armed and too expensive and have insufficient radius of action for anti-submarine work. Small, fast vessels to replace our existing 21-knot frigates are the real answer. There are, fortunately, indications that ships of this type will be forthcoming in the near future as a result of the trials which have been in progress with gas turbines and aluminium hulls. But they must be built in time. As we have seen, aircraft will have far fewer opportunities in the future for locating submarines on the surface. It is also clear that if Russia is to be our enemy, there will be relatively few large enemy surface vessels at sea for aircraft to locate and bomb. It would seem therefore that the main use of aircraft carriers—which is our third and last problem—will be to carry the frontier of the Western Powers to the enemy's coast—to give fighter protection to the bombers and to assist the air forces in bombing communications and industrial plants and factories.

On the other hand, high ranking air force officers, particularly in the U.S.A., maintain that strategical bombing is a job for the air force—the navy's assistance is not required. The U.S. super long-range bomber—"B.36"—has a 5000-mile radius of action with a heavy bomb load and this, it is argued, is more than sufficient to carry an atom bomb from the home base in North America to any major target, as for example, Moscow. Moreover, say the U.S. Air Force, with its supercharged piston engines it can fly 400 miles an hour at 40,000ft and cannot be successfully intercepted by jet fighters. At that altitude, they add, jet fighters lose their marked superiority in speed which they have over the bombers at sea level. Fighter protection is therefore unnecessary.

These arguments are vehemently disputed by the U.S. Navy, who claim that their jet fighters can certainly intercept a bomber at that height—a claim which seems to be borne out by the results of the recent air exercise over Great Britain, when "Vampires"—representing jet bombers—were intercepted without difficulty by "Meteors" and other "Vampires" flying at 35,000ft. Moreover, the U.S. Navy argue, carriers eliminate the need for these super long-range bombers of the "B.36" type. A 40-ton overall load jet-engined bomber, with a 1700-mile radius of action and capable of carrying an atom bomb, had been designed to operate from the 65,000-ton super aircraft carrier, "United States," but the construction of this vessel is not now to be proceeded with. And it was claimed with some justification that, launched from a carrier, this jet bomber could have reached any worthwhile target.

Using jet-assisted take-off units for the take-off, there has been little difficulty in flying off large twin-engined planes from the deck of the 45,000-ton "Franklin D. Roosevelt"—the Lockheed "P2V-2 Neptune" patrol bomber has been flown off with overall loads up to 33 tons—but there is doubt about the practicability of these large, heavy aircraft landing on this class of carrier. Successful landing trials have, however, been carried out on a naval aviation field marked out as a flight deck, and sea trials are to be carried out in the near future. These will probably include new methods of stopping the big plane quickly, such as reversible pitch propellers and reverse jet-assisted take-off units.

Here, in Great Britain, the question of strengthening and improving the flight decks of our carriers to operate heavier and higher performance aircraft is under constant investigation and one of our existing fleet carriers has already been taken in hand for modernisation. In view of the distance factor, however, there seems no need for this country to go in for super long-range bombers such as the "B.36." The fast jet bomber—which, because of its heavy fuel consumption, is not a long-range bomber—seems much more suited to our needs. Moreover, it is reasonable to assume that existing British fleet carriers, built and building, should in the not far distant future be able to operate an adaptation of a land-based jet bomber (with a shorter range) and thus give us the full benefit of our seapower.

Automatic Power Factor and Load Control in a Foundry

AN interesting example of the combined application of power factor improvement and load control equipment in a large works is the installation at Messrs. Lake and Elliot, Braintree, Essex, iron and steel founders, and manufacturers of automobile jacks.

Until a few years ago Messrs. Lake and Elliot operated a works' generating station, which had a capacity large enough to supply their own load and a surplus for other industrial and domestic consumers in the district. As their works' load increased it became necessary to supplement the generating station output with an intake from the supply company.

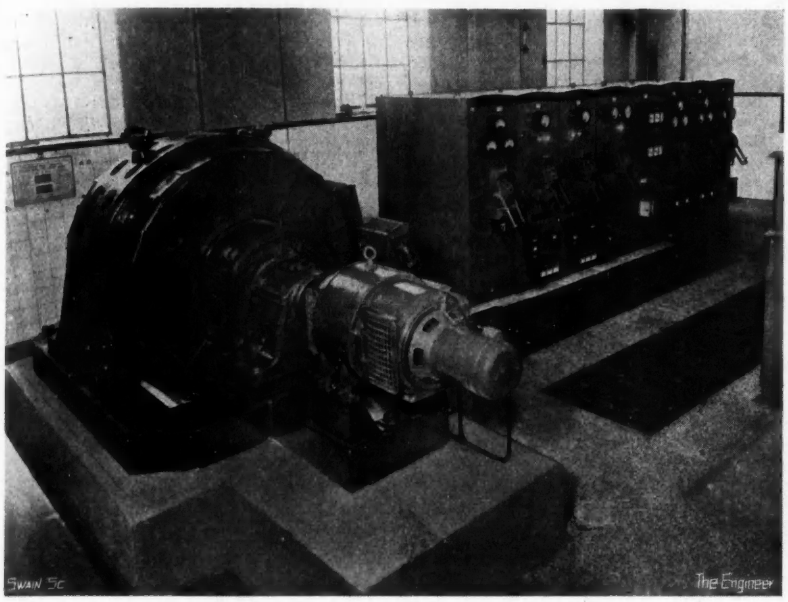
To reduce the kVA loading on the works' low-voltage system, power factor improvement was effected by the installation of a 300-kVA synchronous condenser, with automatic power factor control, in one of the l.v. substations supplied from the private generating plant. Improvement was carried up to 0·95 lagging, which was considered to be the economical limit.

With a further increase in the load demand additional main substation equipment was installed to provide for all power requirements from a high-voltage bulk supply, and the generating plant was dismantled. As the advantages of power factor improvement had by this time been fully proved it was decided to extend the scheme and also install equipment for a complementary method of reducing the kVA maximum demand by load shedding. This programme required the installation of: (1) another synchronous condenser with automatic control for improving the power factor of the entire load intake, and (2) equipment for the controlled load shedding of the arc furnace load to reduce the maximum demand on the system without making any appreciable effect on production.

Each of these schemes can be operated independently to reduce the maximum demand kVA, but in practice they are operated together to obtain accumulative reduction to prevent the maximum demand exceeding a predetermined value. This value was first of all calculated and subsequently adjusted to the opti-

mum value that would allow for the maximum reduction in demand without any loss in works' production.

To improve the power factor of the total load the synchronous condenser is connected to the 6·6-kV busbars in the main high-voltage



SYNCHRONOUS CONDENSER AND 11KV SWITCHGEAR

substation. The substation lay-out consists of 11-kV switchgear controlling three incoming bulk supply feeders, and three 11/66-kV outdoor transformers, with 6·6-kV switchgear (illustrated herewith) controlling feeders to works' substations and furnaces. Transformers were installed when bulk supply was first taken so that the existing 6·6-kV system could be retained, and to limit the short circuit kVA.

The synchronous condenser (illustrated herewith) manufactured by Crompton Parkinson, Ltd., is a 6·6-kV, 750 r.p.m. machine, with a continuous rating of 750kVA reactive leading, and an overload capacity of 25 per cent for two hours. In effect the machine generates reactive kVA for inductive apparatus and thus reduces the amount drawn from the supply. The amount of reactive kVA generated is varied by regulation of the excitation and can therefore be adjusted as the system load changes so as to keep the overall power factor at a higher value.

The machine is easy to start and is fully self-synchronising, the only controls being a stator switch and a contactor-type rotor starter with fully automatic push-button starting and stopping. This starter is shown on the right-hand side of the first illustration overleaf. One of the solenoid-operated oil circuit breakers of the 6·6-kV switchboard is used as the stator switch.

A special feature of the machine is that, in addition to the standard d.c. exciter associated with synchronous machines, it has a pilot exciter for separate excitation of the exciter shunt field to maintain inherent stability over the full range of load.

For power factor control the exciter shunt field regulator is automatically adjusted by a servo-motor; but the regulator can be operated by hand when required. Master control is by an induction power factor relay, which can be pre-set to remain stable at a predetermined value. Any variation from the setting causes the relay to become unbalanced and to rotate in the appropriate direction to close contacts which initiate the operation of relays controlling the servo-motor that adjusts the shunt regulator. The power factor relay had to be designed for satisfactory operation with wide variations of load, often in the form of surges, accompanied by corresponding variations in power factor. It was not practicable to design a power factor relay to follow momentary variations, particularly with the erratic conditions inherent in arc furnace loads, because some form of "hunting" would result. To avoid this, but at the same time obtain an adequate sensitivity, the relay was designed to give proportional control, whereby its speed of response is proportional to the deviation from a pre-set power factor and embodies a measure of integration over short periods.

In practice, the overall automatic power factor control is quite satisfactory under the most severe conditions. Apart from momentary deviations due to load surges, which the relay is not intended to follow, the power factor is automatically maintained at a constant value. The automatic power factor control panel is illustrated overleaf.

Close and smooth adjustment of the reactive kVA and therefore the overall power factor, is obtained by an exciter shunt field regulator with sixty contacts giving small uniform steps of variation.

This installation improves the power factor to 0·95 lagging, which is considered the most economical maximum. The actual overall power factor at times of maximum demand on the system, calculated from the supply company's "tri-vector," is 0·955 lagging.

The loading conditions are such that the machine runs within its nominal rated capacity for most of the day in order to maintain a 0·95 lagging power factor but during peak periods when a higher output of reactive kVA is required to maintain this value the overload rating of 25 per cent for two hours is utilised. The installation effects a reduction of 350kVA in the maximum demand.

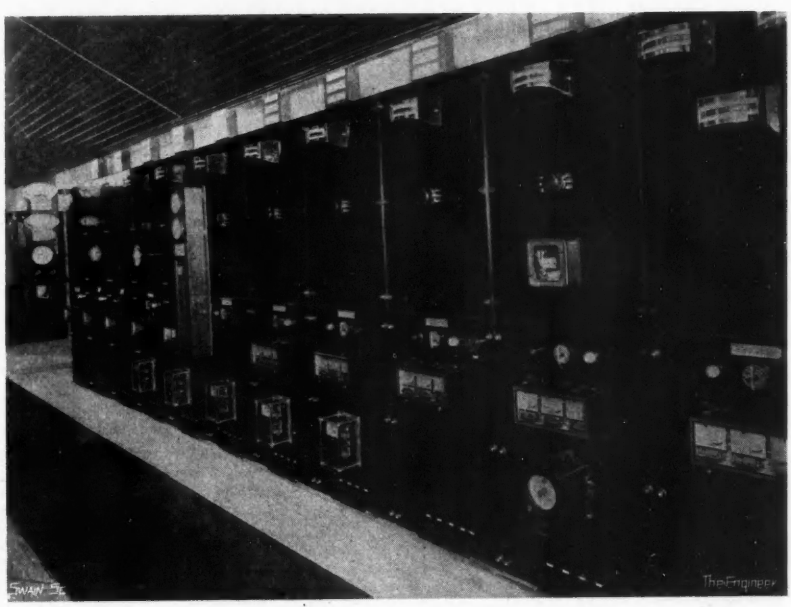
Apart from minimising overall electrical power costs, power factor improvement, by reducing the current for a given kW loading, ensures that switchgear, transformers and cables can be loaded more efficiently, since their current carrying capacities are not partially utilised by the circulation of reactive kVA; and also voltage regulation is improved and the copper losses reduced.

Reduction of Maximum Demand for Load Shedding

The maximum demand control or load shedding scheme is based on the automatic reduction of the power input to an electric furnace. It has been found from experience that the power input can be reduced within certain prescribed limits without materially affecting the operation and output of the furnace, so that for the purpose of maximum demand control the power input is varied by varying the load setting of the automatic furnace controllers, to adjust the on-load tap-changing of the furnace transformer and thereby alter the voltage applied to the electrodes.

In this particular installation the furnace, which was manufactured by the Electric Furnace Company, Ltd., has a capacity of 3 tons and receives its power supply from a B.E.T. 100-kVA transformer fitted with an off-load tap-changing switch.

The maximum demand control equipment was designed and supplied by the Watford



6·6KV SWITCHGEAR CONTROL BOARD

Electric and Manufacturing Company, Ltd. Its function is to over-ride the manual controls of the arc furnaces to restrict the load within limits governed by the total kVA load being taken from the public supply at any particular time. Monitoring is provided by a central control panel (illustrated overleaf) in the main substation for measuring on an integral basis the kVA load over any half-hour, and comparing this

with a reference integration whose summation reaches the predetermined kVA.

The central load-sensitive control for the whole of the system is the comparator, the basic principle of which is a comparison between the voltages across "actual-load" and "available-load" potentiometric elements with adjustable cursors. (The "available-load" is equivalent to the predetermined permissible maximum demand at any time.) The actual-load element cursor is adjusted by an electro-magnetic escapement operated by electrical impulses from an induction type impulse meter, which transmits an impulse after a given quantity of electrical energy has been metered. A synchronous electric clock impulser adjusts the available-load element cursor stepping it forward continuously at a rate determined by the maximum-load setting.

Both the actual-load and available-load elements are maintained in synchronism with the B.E.A.'s meters and at the end of each half-hour integrating period of these meters both elements are reset to zero by a small induction motor drive incorporated in the comparator.

The control is arranged so that as long as the actual-load potential is a predetermined amount lower than the available-load potential, no load reduction takes place. When the actual-load potential approaches to within a predetermined value of the available-load potential a signal is transmitted to the maximum demand load adjusters to effect a reduction of furnace load.

The control is stabilised by means of a device which determines that the load is reduced by just the amount necessary to keep actual-load and available-load potentials equal. Another desirable characteristic of the control is that it does not immediately take off all the available reducible load when required by the maximum demand, but progressively adjusts the load so as to arrive at the required maximum demand at the end of the half-hour period.

For the convenience of the furnace operator, a comparison indicator gives the value of the actual load, together with the value of the available load at the time so that a periodic visual check provides advance warning of the imminence of a load reduction.

A safety check is provided to guard against either the failure of the comparator to effect the necessary reduction of load or unauthorised interference with the automatic features of the load adjusting system. It consists of a kVA integrating meter with a Merz reset element maintained in synchronism with the B.E.A.'s half-hour periods.

The safety-check control is based on the same comparison principle as the normal control. Its trip circuits are so arranged that no unauthorised interference with its operation is possible. Also it is more drastic in its action than the normal control and will actually trip out a furnace instead of reducing its load.

In the foundry the load adjuster consists of a motorised three-phase resistance unit, with elements connected in the load control circuits of the arc furnace, and cursors which are adjusted in accordance with the control impulses. It is provided with an indicator calibrated in percentage load availability. When the maximum demand control permits unrestricted load, the motor runs the cursors to the 100 per cent load availability position and the furnace control regulates the electrical input according to the setting determined by the operator.

As impulses for load reduction are received from the maximum demand control panel, the motor moves the cursors towards reduced load availability. When, for example, the indicator stands at 80 per cent load availability the control will only permit the furnace to take 80 per cent of the setting made by the furnace operator. For the maximum load reduction the electrical input to the furnace is limited to 50 per cent of the setting.

The metallurgical requirements for melting are such that under certain conditions the control must not reduce or otherwise interfere with the electrical input. An interlock on the control ensures that when the furnace is operating on the voltage tapping corresponding to this critical loading, neither the maximum demand control nor the safety check are effective. As, however, critical melting conditions exist only when the furnace is operating at relatively low volts, maximum demand conditions are not likely to occur then.

More than one year's operation of this combined load control system has proved its economic advantages. The maximum demand has been reduced from 2300 to 1800kVA—a saving of 500kVA of maximum demand charges. Of this total 350kVA is due to power factor improvement by the synchronous condenser and 150kVA by furnace load control. The actual financial advantage depends, of course, on the charge per kVA of maximum demand. Taking a representative charge of £4 10s. per kVA, the reduction in demand gives an annual saving of £2250–£1575 from power factor improvement and £657 from furnace load control. It is anticipated that the annual savings will repay the capital cost of the equipment within two to three years and thereafter the savings will produce an annual revenue.

Turbo-Electric Oil Tanker "San Sylvestre"

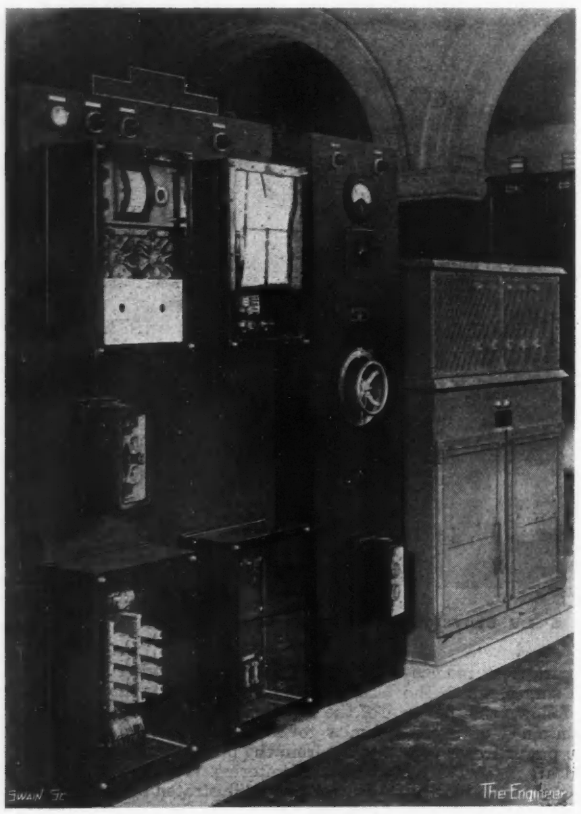
No. I

THE turbo-electric-driven oil tanker, "San Sylvestre," constructed by the Furness Shipbuilding Company, Ltd., of Haverton Hill, for the Eagle Oil and Shipping Company, Ltd., of London, recently entered her owners' service after undergoing successful trials. She is of especial interest, a single-screw turbo-electric ship, embodying in her design the latest principles of oil tanker practice, and was constructed to Lloyd's highest class under its special survey for carrying oil in bulk, and to the specifications prepared by Mr. W. L. Nelson, O.B.E., the company's superintendent engineer.

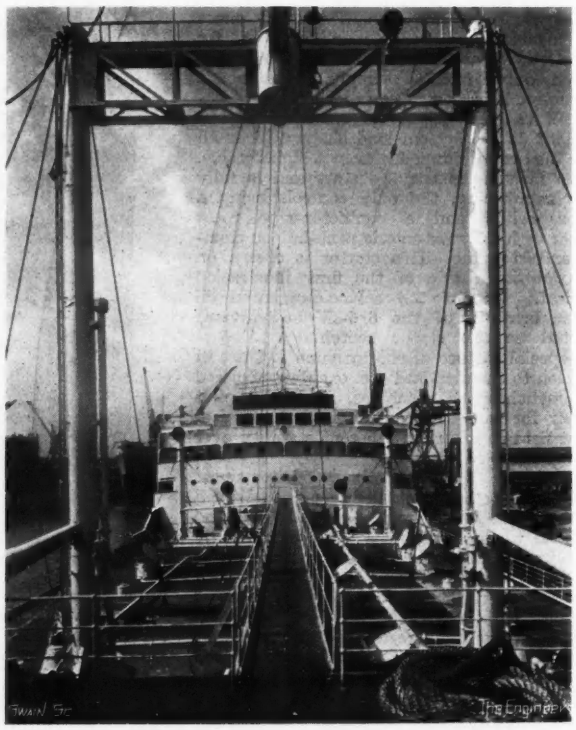
As will be seen from the engraving on the opposite page, she has a poop bridge and forecastle with her machinery fitted aft.

The principal dimensions and particulars of the ship are given in the table opposite.

The vessel is built on the combined system of transverse side framing with longitudinal bottom and decks to lines which have been decided after a comprehensive series of resistance and self-propelled model tests at the National Physical Laboratories.

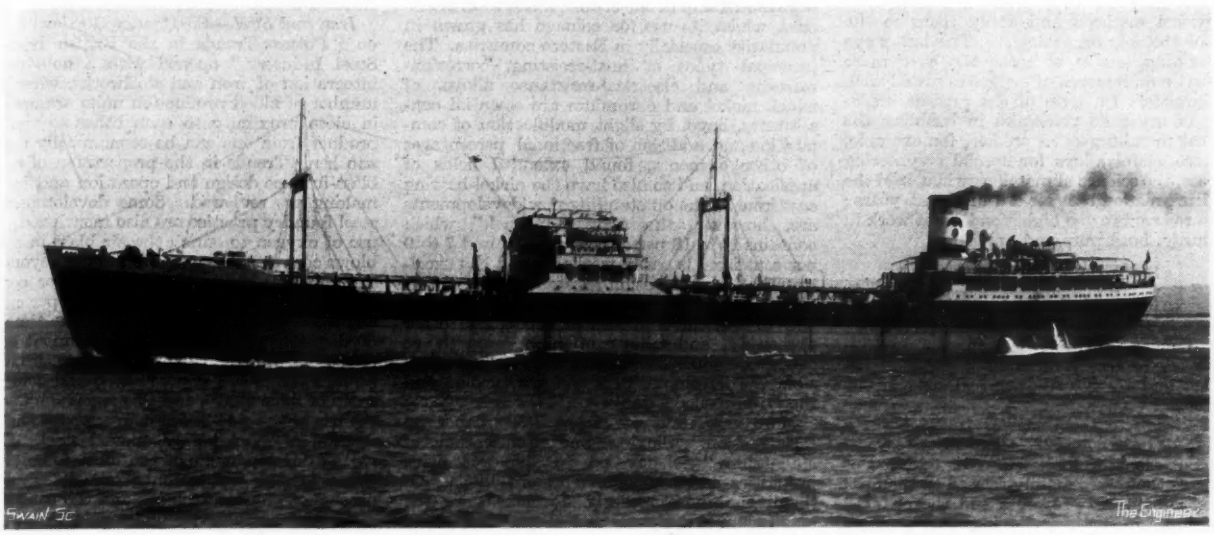


POWER FACTOR AND MAXIMUM DEMAND CONTROL PANELS



DECK VIEW ON TANKER "SAN SYLVESTRE"

Electric welding was extensively employed in the construction, the main transverse and longitudinal bulkheads being of the corrugated type, welded on the "Unionmelt" system as specially developed by the builders. The fore and aft gangway (illustrated on page 232) is constructed of welded "Safe-Tread" flooring. The tank space is divided into nine compartments, eight being treble and one quadruple, making twenty-eight compartments in all. There are two pump rooms, one being between Nos. 3 and 4 tanks, and one between Nos. 6 and 7 tanks. All the cargo and bunker tanks are fitted with heating coils, having a heating surface of 1 square foot per 80 cubic feet of tank capacity. The total cargo capacity is 665,300 cubic feet after allowing 2 per cent for expansion. Oil fuel is carried in a deep tank in the engine-room, the aft cross bunker, the forward cross bunker and the forward deep tank making a total capacity of 2500 tons after allowing 2 per cent for expansion. The feed water is carried in the double bottom under the machinery space, while the domestic water is carried in a large tank in the stern and a tank in the bridge space.



TURBO-ELECTRIC TANKER "SAN SYLVESTRE"

Principal Dimensions

Length overall	537ft
Length between perpendiculars	510ft
Breadth moulded	69ft
Depth moulded	37ft
Deadweight carrying capacity	15,900 tons
Lloyd's summer draught	29ft 2¼in
Service speed	14½ knots
Trial speed about	15¼ knots

Propelling Machinery

Type	Single-screw G.E.C. turbo-electric
Maximum power of propulsion motor	9000 b.h.p.
Normal power of motor	8,300 b.h.p.
Maximum speed of motor	126 r.p.m.
Normal speed	120 r.p.m.
Maximum continuous rating of G.E.C. Fraser and Chalmers turbo-alternator	9,000 b.h.p.
Speed of turbo-alternator at above rating	3,230 r.p.m.

Electric Auxiliary Generating Plant

Two 400-kW, 200-V G.E.C. turbo-generator sets.
One 100-kW Mirrlees G.E.C. oil engine-driven generator set.

Main Boiler Plant

Two Thomson La Mont oil-fired boilers.

Normal load capacity, each boiler	60,000 lb/hr
Working pressure	500 lb/sq in
Temperature at Superheater outlet	800° F.

Auxiliary Boiler Plant

One Thomson steam-steam generator, 10,000 lb per hour.
One Cochran oil-fired boiler, 6000 lb per hour.

Working pressure of auxiliary steam supply	150 lb/sq in

All the cargo tanks are fitted with efficient steaming out, fire-extinguishing and gas-freeing pipes, and are arranged for Butterworth tank cleaning apparatus.

The vessel is rigged as a fore-and-aft schooner with two steel telescopic topmasts. There are two 5-ton and six 2-ton steel tubular derricks worked by Clarke Chapman steam winches. Two Emerson Walker steam warping capstans are fitted in the poop. A powerful steam windlass, also of Emerson Walker's latest design is fitted on the forecastle for working the anchor gear. The rudder, which is of Simplex design, is worked by an electric-hydraulic four-ram steering gear working on the Hele-Shaw Martineau principle, and supplied by John Hastie and Co., Ltd. The controls are arranged from the wheelhouse by telemotor, mechanically from the boat deck aft, and directly from the steering gear compartment.

Refrigerated storerooms are fitted in the poop 'tween decks, comprising a meat room of 1087 cubic feet, a vegetable room of 654 cubic feet, a handling room of 528 cubic feet, and one operated by refrigerating machinery supplied by J. and E. Hall, Ltd., consisting of an electrically operated "Hallmark" twin-cylinder methyl chloride plant designed to maintain a temperature of 20 to 25 deg. Fah. when the vessel is working in the tropics.

Living Accommodation

The living accommodation in this new tanker is particularly roomy and is well furnished, all the public rooms and the captain's and chief engineer's suites having been fitted up and furnished by the Bath Cabinet Company, Ltd., to the builders' designs. The social room and the writing room are panelled and furnished in oak with oak beams, and include a brick fireplace and casement windows all in the Tudor period style. The dining saloon, the captain's and the chief engineer's suites are all panelled and furnished in hardwood, the saloon being furnished in two shades of mahogany. Each officer and engineer has a private room with attached bathroom, while the deck and engine-room crews have single-berth cabins. On the bridge deck there are four two-berth rooms panelled and furnished in mahogany with private bathrooms for the company's officials. Each department of the crew has its own dining-room and, in addition, there is a large recreation room and cinema and a portable open-air swimming pool. All the accommodation is fitted with mechanical ventilation and heating by the thermotank ventilation, and all is in accordance with the latest Ministry of Transport requirements.

Cargo Pumping Arrangements

The cargo pumping arrangement consists of a 10in bore cast iron ring main, with crossovers in each tank having a 10in suction pipe to each centre tank, and an 8in pipe to each wing tank. In addition, in the three aftermost sets of tanks a 4in bore stripping pipe is taken from the main pipe-line. No. 4 tanks are specially fitted for the carriage of lubricating oil, and have separate connections to two special pumps in the after pump room. Each main cargo pump room is a self-contained unit containing two Worthington-Simpson "Numarine" self-priming, two-stage, split-casing centrifugal pumps, running at 1300 r.p.m. and driven by a Mirrlees-Watson turbine of 380 b.h.p. Each pump has a capacity of 300 tons of heavy oil when discharging at 150 lb per square inch. All the pump turbines exhaust to a four-pass condenser installed in the pump room, which is designed to deal with 15,700 lb of exhaust steam per hour with a vacuum of 27·5in Hg. Each condenser is served by a two-stage air ejector complete with inter- and after-coolers. The extraction and circulating pumps are also driven by a steam turbine running at 1500 r.p.m., and the condensate from each pump room is returned to the engine-room through separate lines, from whence it is returned to the main feed system.

In the after pump room only two similar type of pumps to the main cargo pumps are fitted. They are driven by a Mirrlees-Watson turbine of 103 b.h.p., and are constructed to discharge 75 tons of lubricating oil per hour against a pressure head of 150 lb per square inch when running at 1800 r.p.m. These pumps have independent branches from No. 4 tanks only. A vertical lubricating oil cooler for each main and auxiliary cargo pump is provided, the cooling water for which is taken from the condenser circulating system.

The entrance of the pump rooms is in the usual manner from the upper deck, but great pains have been taken by the builders to keep a complete control of pumping operations from the upper level. So as to obviate the waste of distilled water when starting up the plant from cold it was agreed with the owners to fit a special drain tank which is emptied by the vacuum in the condenser. The drain tank has been lifted sufficiently clear of the bilge to prevent any wastage of the tank due to any possible spirit leakages.

No chequer plate platforms are fitted in any part of the pump room, the whole platform arrangement being of spilled grating, which makes the inspection of the apparatus comparatively simple, and obviates any possibility of a dangerous pocket of gas accumulating. The ladder treads are of the "Lionweld" non-slip pattern similar to those fitted in the engine-rooms, and a firm foot grip is thereby assured under all conditions.

In addition to the turbine-driven pumps a small horizontal duplex pump is fitted in each pump room for bilge and final stripping duties. The forehold pump room is somewhat different from the usual run of such pump rooms, and in addition to the horizontal duplex bilge, and ballast pump, a vertical Simplex oil fuel transfer pump is installed. This transfer pump is a duplicate of that which is installed in the engine-room for similar duties.

(*To be continued*)

Metallurgical Topics

Metallurgical Congress and Symposium

(*Continued from page* 123, *July* 29*th*)

THE Fourth Empire Mining and Metallurgical Congress was given an inspiring lead by Sir Henry Tizard's Presidential Address, which was briefly mentioned in "A Seven-Day Journal" on July 15th. After a striking reference to the insignificant ratio of the volume of metalliferous minerals already extracted to the total volume of land to a depth of 1 mile, he remarked that it would certainly be very odd if there were not still many cubic miles of useful and exploitable material. To discover these resources it would be necessary to develop geophysical methods and apply them to the work of the mining geologist. The last stage in providing metals to meet the ever more stringent requirements of engineers rested with metallurgists. In spite of the present inadequacy of scientific principles in enabling the practical metallurgist to predict, for example, the most useful alloys for special engineering purposes, the science of metallurgy had, said the President, made great strides in recent years; and he referred to the high standard of work in metallurgy, both pure and applied.

SOME CONGRESS PAPERS

Progress in metallurgy in many directions was reflected in the proceedings of Sessions H and I of the Congress, held at Oxford on July 15th and presided over by Sir Arthur Smout in the morning and by Sir Andrew McCance in the afternoon.

In addition to the Congress papers already mentioned on page 122, there were several communications of special interest to users of metals, as they were mainly related to the final product, its future prospects and the changes it undergoes in casting, alloying, cold working and heat-treatment.

Non-Ferrous Metals.—There was, for example, Dr. Maurice Cook's paper on "Recent Progress in the Metallurgy of Copper and Copper Alloys," in which he described the general trend towards the mechanisation of metal-working processes and towards greater precision in the technique of fabrication. The introduction of various methods of continuous casting, improvements in rolling mills and in wire-drawing machines, and the use of controlled atmospheres in annealing furnaces have had a markedly beneficial effect on the efficiency of production and have noticeably raised the standard of quality of the product. The production of high-conductivity oxygen-free copper constitutes a major development in metallurgy, and experimentally a metal which gives sound castings has been produced with a hydrogen content as low as 0·000008 per cent and an oxygen content of 0·00004 per cent. To meet particular requirements, deoxidised or oxygen-free copper often receives some small addition of silver, cadmium or chromium to improve strength at normal and raised temperatures, or of tellurium to improve machinability. The function of all these additions was described by Dr. Cook, who also reviewed the development and properties of a very wide range of copper alloys. Among these, though so far limited to new and special applications which do not call for large tonnages, are the heat-treatable copper alloys which are susceptible to temper-hardening. One of the earliest systems in which this was observed was copper-nickel-aluminium, and one of the more recent to be investigated (following the production of electrolytic manganese) was copper-nickel-manganese. The number of known temper-hardenable copper alloy systems is constantly increasing. In 1932 there were 21; by 1939 160 systems had been listed and more have been added since. In a short space and with the aid of over 100 references, Dr. Cook gave a very valuable summary of the present position of copper and of its alloys.

Another paper of wide interest was Sir William Griffiths's review of progress during the last twenty years in the nickel industry and in the development of the application of nickel and its alloys to a great variety of purposes. The paper is comprehensive in its scope and a considerable part of it is devoted to mining developments and to smelting and refining practice; but the applications of nickel receive due attention with the aid of an adequate bibliography. Many of these applications, for example, as an alloy element in steel and as a constituent of certain copper alloys, are of long standing; others are new or at least have rapidly extended during the last twenty years. Pure nickel has found new applications in radio engineering and in the chemical and food industries, whilst its use for coinage has grown in popularity especially in Eastern countries. The principal types of heat-resisting, corrosion-resisting and electrical-resistance alloys, of which nickel and chromium are essential constituents, have, by slight modification of composition and addition of fractional percentages of other elements, found extended fields of application, and so also have the nickel-bearing cast irons. The outstanding new developments are, however, the alloy "Inconel," which contains 14 to 18 per cent chromium and 7 to 9 per cent iron, is easily workable and has excellent heat- and corrosion-resistance; the nickel-aluminium-iron base, permanent magnet alloys, with or without additions of cobalt and other elements; and alloys of high strength at elevated temperatures, which have made possible the development of the gas turbine and the jet-propelled aeroplane.

More than half of Major Ball's paper on "Extraction, Alloying and Fabrication of Magnesium" is devoted to the treatment, properties and uses of magnesium alloys. Of them, the more recently developed are the magnesium-zinc-zirconium alloys—cast and wrought—and the quaternary alloys of magnesium-zinc-zirconium-rare earth elements, which give completely sound and pressure-tight castings in the most complicated shapes and maintain their room temperature properties at 200 deg. Cent. The zirconium-containing alloys have a small grain size and superior mechanical properties, they are free from liability to stress corrosion, are easy to roll, forge and extrude, and can be welded satisfactorily by the argon-arc process. The magnesium-zinc-zirconium alloy (zinc 4, zirconium 0·7 per cent) has been cast into ingots 70in by 20in by 20in and rolled down in one heat by the cogging mill and following rolls of a steelworks to give nearly 300ft of 2in square bar, which was later rolled into section at a speed of 500ft per minute. Magnesium alloys are resistant to atmospheric corrosion except in salt-laden areas, but when protective coatings are used they give excellent service under marine conditions. By the elimination of impurities (particularly iron, nickel and phosphorus) magnesium alloys can now be made possessing resistance to sea water in the unprotected state. Major Ball concludes that, provided designers apply the extensive experience now available, magnesium alloys can be used generally as material for engineering construction.

Mechanical Treatment.—The paper on "The Cold Working of Metals," by Dr. C. H. Desch, is of special interest on account of the increasing use in recent years of cold-rolled sheet and strip—both ferrous and non-ferrous—and the wide employment of various cold working operations to produce articles of particular shape and accurate dimensions, at the same time increasing the hardness and stiffness of the material. Much investigatory work has been done on the practical aspects of cold working and on the precautions necessary to obtain the desired properties and retain them permanently in the cold-worked products; but on the theoretical side the position is not so satisfactory. The paper reviews the whole subject of work hardening in the light of metal structures and the changes induced in them by stress. Dr. Desch discussed the evidence supplied by microscopical, mechanical, chemical and physical methods, and also the part that can be played by X-rays, electron diffraction and the electron microscope in the investigation of the problem. He attaches great importance to the optical microscope as a means of checking deductions from physical theory, and emphasised the utility of the newer techniques of microscopical examination. While rejecting the idea that an "amorphous phase" exists in the grain boundary of a metal, Dr. Desch brought forward numerous arguments in favour of retaining Beilby's hypothesis that a "vitreous phase" is produced by deformation on the surfaces of slip within a metallic crystal.

Iron and Steel.—Sir Charles Goodeve's paper on "Future Trends in the British Iron and Steel Industry" opened with a note on the integration of iron and steelworks, whereby a number of allied production units are operated in close proximity to each other so that the product from one can be economically used in another. Trends in the preparation of ore, in blast-furnace design and operation and in steel making are reviewed. Some developments in steel foundry practice are also mentioned. The use of oxygen to enrich the air blast in a side-blown converter has now been taken beyond the experimental stage. By using 30 per cent of oxygen in the blast (instead of 20·9 per cent in air) steel can be obtained in half the time and 50 deg. Cent. hotter, without detriment to the refractory lining. The high temperature of the liquid steel makes it possible to add cold steel scrap or ferro alloys, and this opens the way for the use of the side-blown converter for the production of more highly alloyed steel. Other recent developments in the steel foundry are the extended application of the "lost wax" process of precision casting and the centrifugal casting of components of irregular contour in high-tensile alloy steels. Such centrifugally cast steel parts show results in test and in service equal to and in some cases better than are obtained with forged components. It would clearly have been impossible for Sir Charles Goodeve, in the short space at his disposal, to have dealt fully with alloy steel developments, but he selected as examples manganese, particularly its use in high-tensile mild steels; silicon, an essential constituent of transformer steels giving very low hysteresis losses and of silicon-chromium steel for valves required to work at high temperatures; chromium, with nickel and other metals an important constituent in engineering steels, as well as being essential in steels resistant to corrosion and to attack by hot gases; and niobium, for use as a carbide stabiliser in stainless steels to avoid weld decay and as a constituent of heat-resisting steels and permanent magnet alloys. Sir Charles Goodeve emphasised the key position of the steel industry in the world economy and the importance of using its products to the best advantage. The implementation of the British steel development plan will require a substantial increase in supplies of iron ore from new sources abroad. Home ore fields are said to be approaching the limit of depth for opencast working, and if home supplies are to be maintained a highly mechanised technique of underground mining will have to be developed in the near future. A difference of opinion as to the urgency of taking steps in this direction was revealed in the discussion, but it was of interest to note that in the very productive Mesabi Range an American company was already carrying out underground work to establish a training centre in view of possible future requirements.

Other papers of interest in connection with iron and steel were "Research and Development in Canadian Steel Foundry Practice," by Mr. S. L. Gertsman, and "Some Aspects of the Use of Refractory Materials," by Messrs. A. T. Green and F. H. Clews.

A very successful congress was brought to a close by tours and works visits arranged for different groups of members in various parts of the country.

A New Scale of Hardness

By G. S. SMITH, B.Sc., F.I.M.

FOR comparing the hardness of various materials, particularly abrasives and minerals, it has been customary to use the Mohs' scale in which ten minerals of increasing degrees of hardness, as measured by scratching, are given the hardness numbers 1 to 10. Each standard mineral of this scale will scratch the one that comes before it, but not the one after. Any other substance can be assessed for hardness on this scale by finding the two consecutive

TABLE I.—*Mohs' Scale and Knoop Hardness Numbers*

Mohs' scale	Knoop number
(1) Talc	—
(2) Gypsum	32
(3) Calcite	135
(4) Fluorite	163
(5) Apatite	360 (parallel to axis)
	430 (perpendicular to axis)
(6) Orthoclase	560
(7) Quartz	710 (parallel to axis)
	790 (perpendicular to axis)
(8) Topaz	1250
(9) Sapphire	—
(10) Diamond	5500 to 6950

standard minerals, one of which can be scratched and the other cannot be scratched by it. It is even possible sometimes to indicate an intermediate degree of hardness. Nevertheless, the test is qualitative rather than quantitative, and it has been supposed that there exists no regular relationship between the different hardness numbers of Mohs' scale.

The metallurgist normally uses an indentation test for assessing hardness, and his measurements are on a quantitative basis. It is true that various forms of scratch-hardness tests have been developed for testing metals, and quantitative assessments are thereby possible, but in general indentation tests seem to be preferred. Moreover, with the introduction of micro-hardness tests certain disadvantages of the indentation test as applied to brittle materials have been removed, and it is now possible to apply the method to glass and minerals that would normally crack with other forms of the indentation test. Thus the indentation method is solving problems that could formerly be dealt with only by some form of scratch test.

The micro-hardness tester uses a very light load and a diamond indentor. The Knoop indentor is pyramidal with long and short diagonals having a high ratio of 7·11 : 1 between their lengths, and the angles are 172 deg. 30 min. and 130 deg. The Vickers indentor is in the form of a square pyramid with an angle of 136 deg. between opposite faces.

With the American Tukon micro-hardness tester embodying a Knoop indentor the results are expressed as Knoop hardness numbers, but the relationship to other scales of hardness has not yet been determined.[1] As regards Mohs' scale, Knoop, Peters and Emerson[2] obtained Knoop hardness numbers for the standard minerals of that scale as shown in Table I.

Some recent work by Khruschov,[3] of the Institute of Mechanical Engineering of the Academy of Sciences, U.S.S.R., has revealed a very interesting relationship between Mohs' scale and micro-hardness numbers, obtained by the use of a diamond indentor of the Vickers type, and has shown that a new scale, which is in the form of a modification of Mohs' scale, can be used on a quantitative basis. No standards are required, since the hardness numbers on the new scale are derived from experimental values of micro-hardness expressed, not in arbitrary units, but as kilogrammes per square millimetre.

Micro-hardness numbers H obtained by Khruschov for the standard minerals of Mohs' scale are shown in Table II, column 3. When these values were plotted against the Mohs' numbers M on logarithmic paper it was found that all of them, except that for diamond, lay nearly on a straight line, corresponding to

$$M = 0{\cdot}675\sqrt[3]{H} \quad . \quad . \quad . \quad . \quad (1)$$

The value for diamond might have been expected to be anomalous, since it has long been realised by many workers that the difference between the hardness of sapphire (or corundum) and diamond is very great in comparison with the differences between other neighbouring members of the scale, and proposals to allocate to diamond the number 15 have been made. The formula (1) would give the hardness of diamond as 14·57 on Mohs' scale.

This hidden regularity in the construction of Mohs' scale is very remarkable when it is considered that the author in his day could not avail himself of the objective methods of evaluating hardness that exist now, and that his choice of materials was more limited.

Values for M calculated from formula (1), using the data of column 3, are given in column 4 of Table II. Column 5 shows the percentage deviation of $M_{calc.}$ from Mohs' number M.

Although the coefficient 0·675 in formula (1) corresponds most closely to the data, Khruschov recommends that it be altered slightly so that the values for the very hard materials 8 and 9, which are in the range of most useful application

TABLE II.—*Mohs' Numbers, Micro-hardness Values and Hardness Numbers Calculated from Formulæ* (1) *and* (2)

Mineral	Mohs' No., M	Micro-hardness, kg/sq mm, H	M_{calc}	Deviation, $\left(\frac{M_{calc}-M}{M}\right)100$	H_o, $(0{\cdot}7\sqrt[3]{H})$
Talc	1	2·4	0·88	−12	0·9
Gypsum	2	36	2·22	+11	2·3
Calcite	3	109	3·22	+ 7·1	3·3
Fluorite	4	189	3·87	− 3·2	4
Apatite	5	536	5·48	+ 9·6	5·7
Orthoclase	6	795	6·25	+ 4·1	6·5
Quartz	7	1,120	7·00	0	7·3
Topaz	8	1,427	7·60	− 5·0	7·9
Sapphire	9	2,060	8·58	− 4·6	8·9
Diamond	10	10,060	14·57	+45·7	15·1

of the formula, should be closer to whole numbers. Accordingly, he bases his new scale of hardness H_o on the definition

$$H_o = 0{\cdot}7\sqrt[3]{H} \quad . \quad . \quad . \quad . \quad (2)$$

where H is the micro-hardness number in kilogrammes per square millimetre.

Incidentally, the use of 0·7 in place of 0·675 simplifies calculations. The H_o numbers for the standards 1, 4, 8 and 9 agree almost exactly with the Mohs' numbers. Column 6 of Table II shows the minerals in the new class of hardness H_o.

TABLE III.—*Micro-hardness and H_o Values of Certain Materials*

Material	Micro-hardness, kg/sq mm	H_o
Tungsten carbide	1,430	7·8
Corundum	2,060	8·9
Complex carbide of tungsten and titanium	2,145	9·0
Titanium carbide	2,900	10
Silicon carbide	3,000	10·1
Diamond	10,060	15·1

Mohs' minerals now lose their status as standards and the new hardness numbers are not relative to those of a set of minerals that may differ somewhat with their origin. The new values are absolute. Furthermore, in place of a whole number scale that in any case is too coarse to show finer differences, we have a scale in which tenths of units are significant.

Values on the H_o scale for certain other materials tested at the Institute of Mechanical Engineering are given in Table III.

REFERENCES

[1] "Metals Handbook," Amer. Soc. for Metals, 1948, page 101.

[2] F. Knoop, C. G. Peters and W. B. Emerson, *J.*, Res. Nat. Bur. Stand., 1939, Vol. 23, page 39.

[3] M. M. Khruschov, *Zavod. Lab.*, 1949, Vol. 15, pages 213–217 (in Russian).

The British Association

THE 112th annual meeting of the British Association for the Advancement of Science will begin at Newcastle-upon-Tyne on Wednesday next, August 31st, and will continue until Wednesday, September 7th. For the period of the meeting, the Association's reception room and administrative offices will be in the University Union, College Road, Newcastle-upon-Tyne. This year's President is Sir John Russell, F.R.S., and his address, which is to be delivered at the City Hall at 8.15 p.m. on August 31st, will be on the subject of "World Population and World Food Supplies."

The meetings of Section G, Engineering, will begin, under the presidency of Sir Arthur Fleming, on Thursday morning, September 1st, when there is to be a discussion on "New Materials and their Engineering Significance," based on papers to be read by Dr. R. W. Sillars, Dr. F. Brailsford and Dr. R. W. Bailey. In the afternoon, a paper on "Yield Pillar Technique in Deep Coal Mining" will be presented by Mr. Haswell Alder, Mr. Arthur Walker and Mr. E. L. J. Potts, followed by one by Professor H. Cotton on "Lighting of the Coal Face." On Friday morning, September 2nd, Section G will discuss "Ground Subsidence," papers being read by Mr. E. L. J. Potts, Dr. T. Robertson, Dr. J. Charlesworth and Mr. G. Raw. At an afternoon meeting, Professor L. C. Burrill will present a paper on "Marine Propulsion: The Designer's Problem." Sir Arthur Fleming will deliver his Presidential Address to Section G on Monday morning, September 5th, the subject being "Bridging the Gap between Science and Industry." At the afternoon meeting, Dr. A. L. Whiteley will lecture on "Electronics," and in the evening members of the Section are invited to a conversazione arranged by the North-East Coast Institution of Engineers and Shipbuilders. The morning of Tuesday, September 6th, is set aside for the presentation of papers by young engineers. They include "Recent Developments in the Use of Coke," by Mr. E. Murphy; "Settlement of Structures on Clay Foundations," by Mr. A. Chisholm; "Propulsion of Ships by Jets," by Mr. H. Watson, and "Electrical Methods of Inducing and Detecting Vibrations," by Mr. G. Snowball. At the final session of the Section on Tuesday afternoon, Dr. J. C. Weston is to lecture on "Heating Research for Houses." In addition to the papers and lectures, arrangements are made in the programme for members of Section G to visit a number of works and to inspect the laboratories at King's College, Newcastle.

There are several items in the programmes of other Sections which will undoubtedly prove of interest to many engineers. Among them may be mentioned the Presidential Address to Section A, Mathematics and Physics, which will be given by Sir Harold Spencer Jones, F.R.S., and will deal with "Some Developments in Astronomical Instruments," and Sir Alfred Egerton's Presidential Address to Section B, Chemistry, which will be on "The Influence of Studies in Combustion on the Progress of Chemistry." In Section F, Economics and Statistics, the papers include: "Planning and Competition in Industry," by Mr. R. M. Shone; "Trends in the Industrial Distribution of Trade Union Membership, 1911–1947," by Mr. J. D. M. Bell, and "The Present Position of the Coal Industry of Great Britain," by Professor A. Beacham. In Section J, Psychology, Dr. N. H. Mackworth and Dr. C. B. Frisby will speak on "Human Problems in the Design of Machinery and Working Methods," and in Section L, Education, two papers by Professor A. F. Burstall and Mr. K. R. Evans will deal with "Technology and the Humanities in Further Education."

Special evening discourses arranged for those attending the meetings will be delivered in the Lecture Theatre of the Literary and Philosophical Society, Westgate Road, Newcastle-upon-Tyne, as follows:—Friday, September 2nd, "Exploration of the Ocean Floor," by Professor Hans. Pettersson; Sunday, September 4th, "The Science of the Living and the Lifeless," by Professor A. D. Ritchie, and Monday, September 5th, "Reality and Evolution," by Dr. Julian S. Huxley.

Industrial and Labour Notes

The Trades Union Congress

The eighty-first annual session of the Trades Union Congress will open at Bridlington on September 4th, and, as in past years, many of its debates will undoubtedly centre around the General Council's report, which was published at the beginning of this week. The report summarises the activities of the General Council during the last twelve months and also sets out recommendations which have been made concerning various matters which the council has examined. The report does not, however, deal with the discussions which have taken place recently between the T.U.C. economic committee and members of the Government on wages, prices and profits. It has already been stated that this matter will form the subject of a special memorandum to be presented to the Congress.

One of the principal items in that part of the report dealing with "Industrial Policy and Organisation" relates to efforts which the T.U.C. has made to stimulate interest in industrial productivity. Reference is made to the series of productivity conferences which the T.U.C. has organised since last September. It is recorded that eleven different unions or federations of unions were invited to discuss with the General Council productivity problems in the industries which they represented. The suggested outline of these discussions covered such matters as workshop information, joint production committees, shop stewards, restrictive or traditional practices, and bottlenecks and shortages. The report goes on to say, however, that up to the end of July only seven of the eleven unions or federations had found it possible to discuss their problems with the General Council.

Summarising the results of these conferences, the report says that while discussion at each of them was related to the particular characteristics of individual industries, there were certain aspects common to most of them. For instance, though there were in most cases overall shortages of labour, where sections of an industry were scattered and where redundancy might not lead to re-employment except at a distance, there was considerable fear of unemployment and a consequent reluctance to participate in measures to increase productivity. Opinions at the conference were divided on production techniques such as motion study, re-deployment, and the attitude to industrial consultants' opinions. Again, the report states, the fear of redundancy as a result of new methods was an over-riding consideration, although where it was clearly shown that workpeople declared redundant could be re-absorbed, there was little or no union opposition. Some unions had proved willing to examine new proposals and in some cases were arranging to have their officers trained in such subjects as work-load assessment and time and motion study. The report adds that opinion was also divided as to the value of joint production committees. All the unions participating in the conferences commented on the apathy—in some cases hostility—of sections of their membership to those committees. Executive committee members themselves, however, were generally convinced of the need for good joint consultative machinery in the factories and workshops, although some unions in favouring works councils sought a wider and more diverse sphere of consultation than had obtained on joint production committees.

The T.U.C. and Nationalised Industries

The T.U.C. General Council's annual report, referred to in the preceding paragraph, sets out in some detail proposals which have been submitted to the Government for improving the administration of nationalised industries. In the main the proposals have resulted from an enquiry which followed from a resolution at last year's Congress stressing the need for greater participation by the workers in the running of the nationalised industries. A questionnaire on the structure and conduct of nationalised industries was accordingly circulated to affiliated unions concerned, and by the end of June this year twenty-seven replies, which are summarised in the report, had been received.

From these replies the T.U.C. economic committee reached certain conclusions which are also set out in the report, and from them the General Council has framed some proposals which it has put before the Government. These proposals cover consultative machinery, training and education, and promotion procedure within the nationalised industries. On the first, the report says that the problem is to secure that, as far as possible, consultative machinery in the nationalised industries is used before policy decisions have been made by management, and that consultation is not merely advance notification to workpeople's representatives of policy decisions which have already been taken, or limited to a consideration of secondary decisions arising out of the basic ones. For the most part, the General Council suggests, the problem is one of getting the proper attitude towards joint consultation on both sides of the nationalised industries as it is not sufficient for each side to express a general readiness to consult and then to await the initiative of the other side. As to training and education, the General Council says that they "should not be exclusively technical, but should attempt to infuse into officials and workpeople an enthusiasm for the success of the nationalised industry, with an explanation of its social and economic background and problems." Training of this character, it is proposed, should be provided for both officials and workpeople. So far as promotion procedure is concerned, the T.U.C. feels that it is too early to pass judgment on the promotion methods being established in the nationalised industries. The report stresses, however, "the importance of the contribution which satisfactory procedure can make towards creating an understanding among workpeople of the new opportunities of a nationalised undertaking."

Engineering Wages

At its quarterly meeting in York, on Wednesday of last week, the Confederation of Shipbuilding and Engineering Unions discussed the subject of wages in the engineering union. The discussion arose from a decision taken in June by the National Committee of the Amalgamated Engineering Union to press for a wage increase of £1 a week. Such an increase, the A.E.U. resolution urged, should become operative as from the date of application and should be met from profit and not added to the price of consumer goods. It is reported, however, that the Confederation did not reach any final decision on the matter last week. A further meeting is to be held in a month's time after the claim has been considered by the executive councils of the thirty-seven affiliated unions.

Railwaymen's Lodging Turns

Train services in parts of the Eastern and North Eastern Regions of British Railways were disorganised on Sunday last by another unofficial token strike of some locomotive men. The strike, like those which occurred in June, was claimed to be a protest against summer schedules involving additional lodging turns, although, as the Railway Executive has explained, the lodging turns concerned have been agreed to by the unions. The recurrence of the trouble centres round two men attached to the Grantham locomotive depot, who refused to work a lodging turn a fortnight ago and consequently could not be "booked on" when they reported next morning for duty at Grantham instead of King's Cross.

In a statement on the matter, issued last Saturday, the Railway Executive stressed the need for a return to the old sense of loyalty and discipline, not only to the public and railway management, but also to the trade unions, so that negotiated agreements were honourably observed by railway staff. The statement pointed out that the number of men directly affected was twenty-four drivers and twenty-four firemen, who would be required to work, on an average, seven lodging turns in 144 days. Moreover, it was explained that these particular lodging turns would cease when the summer schedules came to an end on September 25th.

A meeting between representatives of the Railway Executive and the Associated Society of Locomotive Engineers and Firemen and the National Union of Railwaymen was planned to take place at York on Tuesday last for a further discussion of lodging turn grievances.

Colliery Winders' Strike

An unofficial strike of about 700 winding engine men, which started last week-end, has seriously affected coal production in parts of the Yorkshire and Lancashire coalfields. The men in question are members of the Colliery Winders' Federation, a union which is not recognised by the National Coal Board or the National Union of Mineworkers.

The Federation recently advanced a claim for a wage increase and last month gave the Minister of Labour the customary three weeks' notice of a dispute. The Minister, in turn, decided that the claim should go to the National Arbitration Tribunal, a decision which at first the Federation refused to accept. Ultimately, however, it withdrew a recommendation to its members to strike. Nevertheless, some of the men persisted with the strike threat, despite an appeal by the National Coal Board to remain at work both in their country's and their own interests.

On Tuesday last, at a meeting of the Yorkshire Winding Enginemen's Association, a further appeal for an end of the strike was made, and as we go to press it seems likely that in the Yorkshire coalfield, at any rate, work is being resumed.

British Overseas Trade

The Board of Trade Accounts, which were published on Monday last, show that the value of exports of United Kingdom goods in July was £141,668,399, compared with £143,140,849 in June and £151,405,748 in May. There were twenty-six working days in July—the same number as in May—but only twenty-four in June. Allowing for this, the daily rate of exports in July was 6·5 per cent less than in May and 8·5 per cent less than in June. In fact, as the Board of Trade has pointed out, it was lower than in any month since last October.

Normally, July is a high month for exports, although it was expected that this year's figures would be affected by the London dock strike. Goods for export were, however, diverted to other ports, but as the extent of the diversion is not known, the Board finds it difficult to estimate the full effect of the strike on the month's total. By volume, it is estimated provisionally that July exports were 143 per cent of the 1938 monthly average, compared with 145 per cent in June, 153 per cent in May, and 146 per cent for the second quarter as a whole. Exports of manufactured goods in July totalled £123,673,589, which was about £3,600,000 below the average for the second quarter. The major reduction, the Board of Trade says, was in the vehicles group, which was £2,100,000 below the monthly average for the second quarter. On the other hand, machinery exports were above the last quarter's average, and iron and steel exports, at 219,273 tons, were the highest in value since 1920.

July imports were valued at £186,429,384, the lowest in any month this year apart from February. Imports of raw materials totalled about £62,000,000, the lowest figure recorded since February, and a reduction of £6,800,000 compared with the average for the preceding three months. Re-exports in July were valued at £4,289,371, and the excess of imports over total exports was therefore £40,471,614, compared with about £54,200,000 in June and £37,800,000 in May.

French Engineering News

(From our French Correspondent)

A number of orders for small vessels have been placed by the French mercantile marine. The Ateliers et Chantiers de la Loire de Nantes are to construct a pump-barge with 1800 h.p. diesel electric propulsion machinery, while the Ateliers et Chantiers de Bretagne are to construct a 34m long tug of 470 tons. It will have a 1200 h.p. diesel engine and speed of 12 knots. An 18m long ferry to be constructed by the S.A. des Anciens Chantiers Dubigeon de Nantes will have an 85 h.p. Baudoin diesel engine. An order for twenty-five self-propelling barges has been placed with the Chantier Naval de Cherbourg. Main dimensions are: 900 tons deadweight, 70m long, 8·10m beam and 2·8m draught. The same company will construct sixty self-propelling river barges, 350 tons deadweight, 38m long, 5m beam and 2·6m draught. The Lorient Naval Shipyard is to construct a mixed cargo-packet, 8300 tonnage, 136m long, 19m beam, and propelled by a 5000 h.p. diesel engine. Five self-propelling barges will also be produced by the company.

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Results obtained following the use of Goodman Duckbills in French mines in the Nord and Pas de Calais have been very satisfactory. Two duckbills are being used in these mines. At Bethune a duckbill was used for opening up a 155m seam during which a total of 133·5m were bored at an average of 48cm at each descent compared with a maximum of 35cm without a duckbill. At Henin-Lietard, where a maximum advance in opening up seams was planned, the work would have been very prolonged without the assistance of the duckbill. Where a worker could shift an average of 5 tons with a shovel the duckbill shifted 30 tons.

* * *

According to the annual report of the Chambre Syndicale des Mines de Fer, the increased production required to meet growing demands cannot be assured by simply increasing manpower. In addition, the use of mechanical installations is required, particularly mechanical loading. The new programme drawn up poses serious financial problems for the Lorraine basin mines. Receipts for all the East of France ore mines for the three years 1946 to 1948 inclusive amounted to 1 milliard 250 million francs, which represents only 50 per cent of the expenditure of the companies concerned. Expenditure on the new programme started in January, 1949, has been estimated at 15 milliard francs, and comprises both work taken over from the old programme and new work. The mines themselves cannot finance the equipment needed and a future bottleneck in steel production may result from lack of ore. Steel production in 1948 increased, thanks to adequate fuel supplies, but this also meant that stocks of ore were drawn upon. In the Lorraine mines, the effort to develop mechanical loading was continued, the percentage increasing from 37 per cent in 1947 (representing 26,000 tons daily) to 46 per cent in December, 1948 (43,000 tons daily).

* * *

The return of plentiful supplies of scrap iron will create export problems for France. Before the war French prices were distinctly lower than international rates, but since the war French merchants agreed to create a professional tax to bring French prices into line in order to avoid repercussions on the national market. Now, thanks to a vast programme, recovery of scrap has been intensified and the French steel industry is adequately supplied. Already tonnages available are in excess of industrial needs. At the same time, international prices have dropped considerably, American and Belgian prices being practically the same as French prices. Priority supplies are satisfactory although non-priority needs remain to be completely filled. In order to deal with the situation which will arise when all home needs are satisfied, the authorities are considering a measure to permit a limited export of scrap, particularly to countries which have already asked for scrap to be included in commercial agreements.

Notes and Memoranda

Rail and Road

LIVERPOOL'S MODEL RAILWAY EXHIBITION.—A Model Railway Exhibition is to be held in St. George's Hall, Liverpool, from September 1st to 10th. Exhibits arranged by British Railways include 500ft of track of flat-bottomed rails of the latest pattern fixed to sleepers resting on ballast. There is also a station specially designed on modern post-war lines, a signalbox, goods depot, sidings and engine shed. Scale models of express trains which normally are to be seen on each Region, a new express diesel engine and a diesel shunting engine will run round tracks, which are laid out roughly in the form of a rectangle about 30ft by 20ft. The railway is electrically operated, train movements being remotely controlled. Other models in the show will be Edge Hill marshalling yard (L.M.R.), Mersey Docks, Bar Lightship, two models of the Wallasey ferry boat, two models of the Birkenhead ferry boat, a diesel locomotive, a restaurant car, two push-button working locomotives, and models from the Liverpool Model Railway Club.

Air and Water

RENFREW AIRPORT.—The Ministry of Civil Aviation has just published, through H.M. Stationery Office, an illustrated booklet entitled "Renfrew: Airport for Glasgow." As well as describing the development and organisation of the airport, it contains many useful and interesting details concerning the air services now using it.

LONDON AND NORTHOLT AIRPORTS.—The Ministry of Civil Aviation's Operational Research Section is at present making a detailed analysis of traffic movements at London and Northolt airports. The object of the analysis is to determine if there are any unnecessary and avoidable delays in the flow of aircraft, passengers and baggage, and also to estimate the traffic capacity of the airports for the summer of 1950. The Ministry says that with the accurate information which the analysis will provide, operators will be able to arrange their timetables so that as far as possible the airports are not overloaded and delays are cut to the minimum.

SNOWY RIVER BOOKLET.—The Australian Department of Information has recently issued a twenty-four-page booklet entitled "Wealth from the Snowy." The booklet has been prepared at the request of Mr. Nelson Lemmon, Minister for Works and Housing, and is intended to show the possibilities of the power and irrigation developments planned in the Snowy Mountains area. It describes, in simple terms, the various factors involved in the developments and gives an outline of the two alternative schemes which are at present under consideration. There are numerous illustrations of rivers and dam sites, and the explanation in the text is supplemented by a number of diagrams.

FIFTH INTERNATIONAL CONFERENCE OF SHIP TANK SUPERINTENDENTS.—The "Proceedings" of the fifth Conference of Ship Tank Superintendents, which was held in London in September, 1948, have now been published in book form by the Stationery Office, London. The volume contains a complete record of the prepared papers and discussions, summaries of the free discussion, and a statement of the decisions and recommendations of the Conference. The four subjects discussed were: "Comparative Tests of Propellers in Cavitation Tunnels"; "The choice of Suitable Reynolds Number for Model Propeller Experiments"; "The Use of Turbulence-Producing Devices in Model Experiments," and "Skin Friction." A limited number of copies are available for purchase at 7s. 6d. net each from the Stationery Office or through any bookseller.

Miscellanea

WORLD ENGINEERING CONFERENCE.—The World Engineering Conference, the headquarters of which are in Paris, has been advised that the United Nations' Economic and Social Council has recently adopted a resolution according it "consultative status." The office of the British section of the Conference is at 82, Victoria Street, London, S.W.1.

INTERNATIONAL CONFERENCE OF ENGINEERS' ASSOCIATIONS.—At a recent meeting of experts, convened by UNESCO, arrangements were considered for an International Conference of Engineers' Associations to be held during 1950. Its purpose would be to discuss means for improving international co-operation in all fields of engineering science. A provisional consultative committee has been formed under the chairmanship of Monsieur Eric Choisy, President of the Société Suisse des Ingénieurs et des Architectes.

RADIO COMPONENTS EXHIBITION, 1950.—The seventh annual Exhibition of British Components, Valves and Test Gear for the radio, television, electronic and telecommunication industries will be held in the Great Hall, Grosvenor House, Park Lane, London, W.1, from Monday, April 17, to Wednesday, April 19, 1950. Admission is by invitation of the organisers, the Radio and Electronic Component Manufacturers' Federation (22, Surrey Street, Strand, London, W.C.2).

INSTITUTION OF PRODUCTION ENGINEERS.—The Institution of Production Engineers has announced the formation of three new local sections, in Auckland (New Zealand), Bombay and Dundee. The first meeting of the Dundee section will be held on October 4th. The formation of the Bombay section—the second branch of the Institution in India—has been influenced by the rapid growth of industry in this part of India, and the Auckland section is also of interest, as it is the first branch of the Institution to be formed in the Dominion of New Zealand.

CHEMICAL SOCIETY'S RESEARCH FUND.—The research fund of the Chemical Society provides grants for the assistance of research in all branches of chemistry, there being about £700 per annum available for the purpose. The Society announces that applications for grants will be considered in November next and should be submitted on the appropriate form not later than Tuesday, November 1, 1949. Applications from Fellows will receive prior consideration. Forms of application, together with the regulations governing the awards of grants, may be obtained from the General Secretary, The Chemical Society, Burlington House, Piccadilly, London, W.1.

NEW TOWN AT CORBY.—The Minister of Town and Country Planning has recently held discussions with representatives of the appropriate local authorities about his proposal to establish a new town at Corby, Northants. The present suggestion is that an area of about 3000 acres, suitable ultimately to accommodate a new town of about 40,000 people, should be designated under the New Towns Act, 1946. During the discussions, the Minister urged that the need for a new town at Corby had been demonstrated as the already large number of workers in the steel industry in the area would increase by thousands when further expansions were carried out.

LECTURES ON CONCRETE TECHNOLOGY.—A course of nine weekly lectures on "Concrete Technology" is to be given by Mr. J. Singleton-Green, A.M.I.C.E., M.I. Struct. E., president of the Reinforced Concrete Association, at the L.C.C. Brixton School of Building, Ferndale Road, S.W.4, on Monday evenings at 6.30 p.m. beginning on October 10th. The lectures are intended mainly for those responsible for the direction of concrete work, and admission to the course will generally be restricted to those whose technical qualifications or experience are such as to enable them to contribute to the discussions on the various aspects of the subject. Consideration will be given in the lectures to the problems of selection and specification of materials, concreting techniques, organisation and supervision. It is generally recognised that further developments in the use of concrete in this country are restricted by the shortage of trained and experienced technical men at all levels, and it is hoped that the lectures will prove a valuable addition to the facilities available for the study of concrete technology.

RADIOLYMPIA OPENING.—Mr. Herbert Morrison, M.P., Lord President of the Council, is to open the sixteenth National Radio Exhibition ("Radiolympia") at Olympia, London, on the afternoon of Wednesday, September 28th. The Royal Navy, the Army and the Royal Air Force will exhibit their radio and radar equipment at Radiolympia for the first time since the war. The Department of Scientific and Industrial Research (for which Mr. Morrison is the responsible Minister), the various research establishments of the Ministry of Supply, the G.P.O. and the Ministry of Civil Aviation will give popular demonstrations, and the Board of Trade is to have offices adjoining the Radio Industry Council's rooms for the reception of overseas visitors. Many new models of radio and television receivers—some of these for the new Midlands station—are promised by manufacturers, and the public will see rehearsals and performances in the B.B.C. television studio or on the screens of television sets of every make which will be working side by side in communal viewing halls. Mobile and "business radio," transmission of newspaper photographs by radio, the use of radar and other navigational aids and electronic industrial equipment will also be demonstrated by leading manufacturers.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Aslib.

Fri., Sept. 9th to Mon., Sept. 12th.—Annual Conference at Ashorne Hill, near Leamington Spa, Warwickshire.

Engineering and Marine Exhibition

To-day, Aug. 26th, to Sat., Sept. 10th.—Olympia, London.

Incorporated Plant Engineers

Fri., Sept. 2nd.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, "The Preparation of Granite for Roads," C. G. Kitchingman, 7.30 p.m.

Tues., Sept. 6th.—S. WALES BRANCH: Grand Hotel, Cardiff. "Lubrication," by a technical representative of Vacuum Oil Company, together with a film entitled "The Inside Story," 7.30 p.m.

Thurs., Sept. 8th.—NEWCASTLE-UPON-TYNE BRANCH: Turks Head Hotel, Newcastle-upon-Tyne, "Materials Handling Equipment," L. Walmsley, 7.15 p.m.

Institute of Road Transport Engineers

Wed., Sept. 7th.—LONDON BRANCH: Visit to Shell Haven Refineries, 10.30 a.m.

Institute of the Motor Industry

Sat., Aug. 27th, to Sat., Sept. 10th.—St. Catherine's College, Cambridge, third annual summer school.

Institute of Welding

Thurs., Sept. 8th.—Visit to the Engineering and Marine Exhibition at Olympia, London, W.8.

Institution of Naval Architects

Tues., Aug. 30th, to Fri., Sept. 2nd.—Autumn meeting, Copenhagen.

Institution of Production Engineers

Sat., Sept. 3rd.—BIRMINGHAM GRADUATE SECTION: The University, Bristol Road, Birmingham, Graduates' Conference on "Training and Leadership in Production Engineering," 9.15 a.m. to 5.30 p.m.

Wed., Sept. 7th.—WOLVERHAMPTON SECTION: Wolverhampton and Staffordshire Technical College Institute, Wolverhampton, "Atomic Physics," 7 p.m.

Thurs., Sept. 8th.—NOTTINGHAM SECTION: Visit to the Standard Motor Co., Ltd., Coventry, 9.30 a.m.

Fri., Sept. 9th.—W. WALES SUB-SECTION: Technical College, Swansea, "Air in Industry," C. W. Wheal, 7.30 p.m.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report	Title	Post free s.	d.
B.I.O.S.			
1250	Report on German Engineers' Tool Industry	9	3
1631	Lurgi Apparatebau and Lurgi Chemie Frankfurt A.M.—Design of Sulphuric Acid Plants	3	2
1641	Norddeutsche Affinerie-Hamburg —Manufacture of Sulphuric Acid	4	8
1820	Heating, Ventilating and District Heating in Germany...	30	6
1858	(Report No. 9, Agriculture Overseas) Green Crop Conservation in Germany	1	1
Classified List			
No. 18 ...	Consolidated list under subject headings of all reports on German and Japanese Industry published up to and including March 31, 1948	1	3
No. 19 ...	Reports published between April 1st and August 31st, 1948... ...	0	3
Technical Index			
(Part 1) ...	Alphabetical Subject Index of Reports on German Industry: Reports published to July, 1946	5	3
(Part 2) ...	Reports published during August, September and October, 1946...	1	7
(Part 3) ...	Reports published during November and December, 1946	1	7
(Part 4) ...	Reports published during January, February and March, 1947	2	2
(Part 5) ...	Reports published during April/September, 1947	3	8
(Part 6) ...	Reports published during October, 1947, and March 27, 1948...	2	8

Technical Information and Documents Unit, German Division, Board of Trade, 40, Cadogan Square, S.W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

Personal and Business

MR. G. R. MARSH has been appointed assistant managing director of A. C. Wickman, Ltd.

MR. N. G. BASSETT SMITH has been appointed manager of the flexible plastics division of Dunlop, Ltd.

MR. W. A. SMYTH, M.I.Mech.E., has been appointed a director and general manager of Henry Meadows, Ltd., Wolverhampton.

MR. A. P. QUARRELL, A.M.I.Mech.E., a director of Associated British Oil Engines, Ltd., has been appointed to the board of British Oilfield Equipment Company, Ltd.

MR. F. J. MARK has been appointed Manchester representative of E. H. Jones (Machine Tools), Ltd. He will operate from the company's branch office at 34, Ardwick Green South, Manchester, 13.

THE MINISTER OF TRANSPORT has appointed Mr. H. V. Stammers to be a deputy member for England and Wales of the Road and Rail Appeal Tribunal. Mr. Stammers is a managing director of the British Tabulating Machine Company, Ltd.

MR. CECIL BENTHAM, M.I.C.E., M.I.Mech.E., has now retired from the board of Henry Simon (Holdings), Ltd., but is continuing active engineering and industrial work on his own account. A new company named Cecil Bentham, Ltd., has been formed with registered offices at Ashbourne House, 334, Wellington Road North, Stockport.

METALCLAD, Ltd., announces that its administration and manufacture of woodworking machinery have now been centralised at Stanningley Works, near Leeds. The necessary iron castings will be produced at the company's new foundry at Morriston, Glamorgan. All the firm's woodworking machinery sales will in future be handled by the parent company, George Cohen, Sons and Co., Ltd. Export enquiries will be dealt with at Wood Lane, London, W.12, and home enquiries at Sunbeam Road, London, N.W.10, and at the Cohen group's branches throughout the country.

THE FEDERATION OF CONSTRUCTION MACHINERY IMPORTERS OF GREAT BRITAIN AND NORTHERN IRELAND has been formed under the chairmanship of Mr. R. G. Ledger, of Mackay Industrial Equipment, Ltd., with the object of promoting the interests of construction machinery importers. The Federation includes as founder members: Auto Diesels, Ltd.; John Blackwood Hodge and Co., Ltd.; Eltee Equipments, Ltd.; General Motors, Ltd.; H. Leverton and Co., Ltd.; L. O. Tractors Ltd.; Mackay Industrial Equipment, Ltd., and Jack Olding and Co., Ltd. Correspondence should be addressed to the Federation's secretary, c/o. Deloitte, Plender, Griffiths and Co., 5, London Wall, Buildings, London, E.C.2.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at **28,** *Victoria Street, London, S.W.1.*

SALE OF OVERSEA STANDARDS IN THE UNITED KINGDOM

It appears that it is not sufficiently well known that the British Standards Institution acts as the agent in the United Kingdom of all oversea national standards organisations. At the present time, when every possible avenue for export is being explored many concerns write direct to standards organisations oversea, only to be referred to the B.S.I. Time and money will be saved by applying directly to the British Standards Institution for all information regarding standards, both home and oversea.

ACCEPTANCE TESTS FOR POSITIVE-DISPLACEMENT COMPRESSORS AND EXHAUSTERS

No. 1571 : 1949. These acceptance tests lay down the conditions under which reciprocating and rotary compressors and exhausters shall be tested in order that guarantees made by manufacturers in regard to output, power consumption or speed may be verified. Deviations of the test conditions from the guarantee conditions within which the tests are applicable are noted and guidance on pressure and temperature measurement is given. A recommended form of test report is also included, together with diagrammatic arrangements of the test lay-outs for the four types of machines covered. In drawing up the standard tests, every endeavour was made to minimise the corrections which have to be applied to the test results to provide for the deviation between the test and the guarantee conditions. The corrections to power consumption for variations of inlet pressure and pressure ratio are therefore extremely simple, provided that these are within the standard deviation. No correction is applied to power consumption for variations of cooling water temperature within the 15 deg. Fah. deviation from guarantee conditions permitted. Experiments at cooling water temperatures differing by 30 deg. Fah. have shown that the difference between friction horse-power due to the changes in oil temperature which are created through changes in water temperature—for which no correction can be made—have as much influence on the power consumption as the variation in the cooling water temperature. This standard is to be followed by a further standard which will deal with acceptance tests for aero-dynamic or turbo-type compressors and exhausters. Price 2s. 6d., post free.

NON-REINFORCED DIAMOND DIES FOR WIRE DRAWING

No. 1168 : 1949. This Standard was originally prepared by the Diamond Die and Tool Control of the Ministry of Supply in collaboration with the British Standards Institution and was first issued in 1944 as a War Emergency British Standard. Experience of the use of the specification has suggested the desirability of certain amendments in the tables relating to the dimensions of the stones in order that the scheduled dimensions may be more closely in accord with those economically obtainable from natural stones. In all other respects the specification remains unaltered and its general usefulness to industry having been proved it is now issued in this revised edition as a regular British Standard. The specification relates to non-reinforced dies with bores up to 0·06in diameter. It indicates the desirable characteristics of the stone and defines the appropriate minimum wall thicknesses and minimum weights for various bores. Provision is made for three grades of finish of the hole: its dimensional accuracy is prescribed and notes are included on methods of examining and measuring the bores. The essential dimensions of the die case are specified, together with a marking system indicating the material for which the die is suitable. An appendix gives detailed large-scale diagrams of typical profiles of die bores for drawing copper, bronze, resistance, steel and tungsten wires. The present edition includes an additional appendix which reproduces a monograph by Dr. D. P. Dudding on the relation between the dimensional characteristics of commercially graded stones and the requirements which are laid down in the specification. Price 2s. 6d., post free.

BEVEL GEARS

No. 545 : 1949. The 1949 edition of this Standard has just been published. It represents a complete revision of its predecessor and is the result of an exceptional amount of painstaking work by the Committee responsible for it. The previous edition contains certain features that have lasted from a time when few were disposed to question them, only to be discarded in an age when critics are numerous, knowledgeable and indifferent to tradition. The definitions have been revised with exceptional diligence and the aim has been to combine rigour and brevity without pedantic working, but it is too much to hope that no purist will find any fault in them. The overlap ratio of helical bevel gear teeth comes into prominence because it is now rightly used in assessing load capacity. The basic tooth form is defined more accurately than heretofore and the method of determining appropriate addendum modification covers every case likely to occur in normal practice. Inconsistencies in the previous formulæ for tolerance on pitch are avoided in the simpler ones that now replace them, and the new expressions for load capacity include important factors that were ignored or inadequately represented in the 1934 edition of this Standard. As before, there are a number of typical calculations of load capacity worked out in detail and the factors used in them are determined from charts that have been redrawn to improve accuracy and ease of reading. In such calculations a "life factor" is now used to take into account the length of life expected from the gears under consideration. Price 7s. 6d., post free.

ALUMINIUM IN SERVICE.—We have received a copy of a well-produced illustrated brochure, entitled "Aluminium in Service," which the Aluminium Development Association has recently published. Its purpose is to show the behaviour of aluminium and its alloys in many different fields and over the longest possible periods. Among the fields of application of aluminium with which the brochure deals are sea, air and land transport; buildings and structures; mining equipment; the food trades; transmission cables, and several miscellaneous items of domestic equipment. The brochure is available at 3s. 6d. a copy from the Aluminium Development Association, 33, Grosvenor Street, London, W.1.